

EXHIBIT A



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
90/008,327	11/09/2006	6229366	10414-25	7730

7590 01/22/2007

James Y. Go
 BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP
 12400 Wilshire Blvd.
 Seventh Floor
 Los Angeles, CA 90025-1026

EXAMINER

ART UNIT

PAPER NUMBER

DATE MAILED: 01/22/2007

Please find below and/or attached an Office communication concerning this application or proceeding.

Order Granting / Denying Request For Ex Parte Reexamination	Control No.	Patent Under Reexamination	
	90/008,327	6229366	
	Examiner	Art Unit	
	Margaret Rubin	3992	

--The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

The request for *ex parte* reexamination filed 09 November 2006 has been considered and a determination has been made. An identification of the claims, the references relied upon, and the rationale supporting the determination are attached.

Attachments: a) ☐ PTO-892, b) ☒ PTO/SB/08, c) ☐ Other: _____

1. ☒ The request for *ex parte* reexamination is GRANTED.

RESPONSE TIMES ARE SET AS FOLLOWS:

For Patent Owner's Statement (Optional): TWO MONTHS from the mailing date of this communication (37 CFR 1.530 (b)). **EXTENSIONS OF TIME ARE GOVERNED BY 37 CFR 1.550(c).**

For Requester's Reply (optional): TWO MONTHS from the **date of service** of any timely filed Patent Owner's Statement (37 CFR 1.535). **NO EXTENSION OF THIS TIME PERIOD IS PERMITTED.** If Patent Owner does not file a timely statement under 37 CFR 1.530(b), then no reply by requester is permitted.

2. ☐ The request for *ex parte* reexamination is DENIED.

This decision is not appealable (35 U.S.C. 303(c)). Requester may seek review by petition to the Commissioner under 37 CFR 1.181 within ONE MONTH from the mailing date of this communication (37 CFR 1.515(c)). **EXTENSION OF TIME TO FILE SUCH A PETITION UNDER 37 CFR 1.181 ARE AVAILABLE ONLY BY PETITION TO SUSPEND OR WAIVE THE REGULATIONS UNDER 37 CFR 1.183.**

In due course, a refund under 37 CFR 1.26 (c) will be made to requester:

- a) ☐ by Treasury check or,
b) ☐ by credit to Deposit Account No. _____, or
c) ☐ by credit to a credit card account, unless otherwise notified (35 U.S.C. 303(c)).

Margaret Rubin
Primary Examiner
Art Unit: 3992

cc:Requester (if third party requester)

Application/Control Number: 90/008,327

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Art Unit: 3992

DECISION GRANTING EX PARTE REEXAMINATION

Information Submissions

Information Submissions in *Ex Parte* Proceedings are bound by 37 CFR § 1.555 which incorporates 37 CFR § 1.98(a). It appears as if Requester made typographical errors in transcribing the title of citation CB and the date of citation CC. Further, page numbers were not supplied for citations CB, CC and CD. Corrections have been made by the Office on PTO form 1449.

Summary

Substantial new questions of patentability affecting claims 1, 2, 8, 9, 10, 14, 16 and 18 of United States Patent No. 6,229,366 (hereafter "the base patent") are raised by the following references:

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- 1.) SGS-Thomson "TEA2262, Switch Mode Power Supply Controller"
pp. 1-9 (April 1996) (hereafter, "TEA2262");
- 2.) U.S. Patent No. 4,638,417 to Martin;
- 3.) "Programmed Pulsewidth Modulated Waveforms for
Electromagnetic Interference Mitigation in DC-DC Converters";
IEEE Transactions on Power Electronics, Vol. 8, No.4 (October
1993) by A.C. Wang and S.R. Sanders, pp. 596-605 (hereafter
"Wang");
- 4.) Unitrode UCC 3800/1/2/3/4/5 biCMOS Current Mode Control
IC's, Bill Andreyckak, pp. 9-344 - 9-361 (1994) ("U-133") and
- 5.) "Off-Line Power Integrated Circuit for International Rated
60-watt Power Supplies" by Richard Keller, Applied Power
Electronics Conference and Exposition, February 1992 (pp. 505-
512) (hereafter, "Keller").

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Issues Raised by Requester

Although the merits of the rejections suggested in the request are not decided herein, it is noted that the Requester proposes that the references supplied raise substantial new questions of patentability when viewed in the following manner:

- 1.) "Claims 1, 2, 8, 9, 10, 14, 16 and 18 are rejected under 35 U.S.C. §§102(a)(b) as anticipated by TEA2262";
- 2.) "Claims 1, 2, 8, 9, 10, 16 and 18 are rejected under 35 U.S.C. §§102(a)(b) as anticipated by Keller";
- 3.) "Claim 14 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Keller in view of Martin or, alternatively, in view of Wang"; and
- 4.) "Claims 1, 2, 8, 9, 10, 16, and 18 are rejected under 35 U.S.C. §§102(a)(b) as being anticipated U-133."

Background

The base patent issued from United States Patent Application No. 09/573,081 (hereafter "the base application").

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The base application was allowed in the first Office action. It is noted that a statement regarding allowable subject matter mailed December 13, 2000 cited "a pulse width modulation circuit comprising a switching transistor wherein the switching transistor can be driven into a non-conducting state by a maximum duty cycle signal, a drive circuit, or a soft start circuit." It is noted that there are two independent claims within the base patent: claims 1 and 9. Neither of them include recitation of a switching transistor. In addition, claim 9 does not require a pulse width modulation circuit, or a maximum duty cycle signal. Lastly, claim 1, for instance, requires that a switch allows a signal to be transmitted between first or second terminals in accordance with a drive signal. The drive signal is provided "according to said maximum duty cycle signal" and a signal from the soft start circuit instructs the drive circuit "to disable said drive signal during at least a portion of said on-state of said maximum duty cycle." Assuming that the switch recited in claim 1 correlates with the switching transistor of the before mentioned reasons for allowance, the reasons for allowance describes different causal relationships between recited elements. In a similar fashion, the causal relationship between recited elements of claim 9 differs from the description included in the reasons for allowance.

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In summary, the prosecution history does not provide a clear record of the reasons the base patent was allowed.

TEA 2262

It is agreed that TEA 2262 raises an SNQ for claims 1 and 9. More particularly, Requester has provided plausible item-matching for a number of limitations of claims 1 and 9 on pages 8-12 and 15-18, respectively, of the request. In view of the fact that the prosecution history does not provide a clear record of the reasons the base patent was allowed, the teachings presented in the request cannot be judged as merely cumulative. By raising an SNQ with regard to independent claims 1 and 9, an SNQ is also raised for the dependent claims 2, 8, 10, 14, 16 and 18 which come freighted with the limitations of the claims from which they stem.

Such teachings are not cumulative to any written discussion on the record of the teachings of the prior art, were not previously considered nor addressed during a prior examination and the same question of patentability was not the subject of a final holding of invalidity by Federal Courts.

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Keller

It is agreed that Keller raises an SNQ for claims 1 and 9. More particularly, Requester has provided plausible item-matching for a number of limitations of claims 1 and 9 on pages 24-25 and 29-31, respectively, of the request. In view of the fact that the prosecution history does not provide a clear record of the reasons the base patent was allowed, the teachings presented in the request cannot be judged as merely cumulative. By raising an SNQ with regard to independent claims 1 and 9, an SNQ is also raised for the dependent claims 2, 8, 10, 16 and 18 which come freighted with the limitations of the claims from which they stem.

Such teachings are not cumulative to any written discussion on the record of the teachings of the prior art, were not previously considered nor addressed during a prior examination and the same question of patentability was not the subject of a final holding of invalidity by Federal Courts.

Martin and Wang

It is agreed that Martin and Wang raise an SNQ for claim 14. More particularly, Requester has provided plausible item-

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matching for a number of limitations of claim 14 on pages 32-35, respectively, of the request. In view of the fact that the prosecution history does not provide a clear record of the reasons the base patent was allowed, the teachings presented in the request cannot be judged as merely cumulative.

Such teachings are not cumulative to any written discussion on the record of the teachings of the prior art, were not previously considered nor addressed during a prior examination and the same question of patentability was not the subject of a final holding of invalidity by Federal Courts.

U-133

It is agreed that U-133 raises an SNQ for claims 1 and 9. More particularly, Requester has provided plausible item-matching for a number of limitations of claims 1 and 9 on pages 41-42 and 44-45, respectively, of the request. In view of the fact that the prosecution history does not provide a clear record of the reasons the base patent was allowed, the teachings presented in the request cannot be judged as merely cumulative. By raising an SNQ with regard to independent claims 1 and 9, an SNQ is also raised for the dependent claims 2, 8, 10, 16, and 18

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which come freighted with the limitations of the claims from which they stem.

Such teachings are not cumulative to any written discussion on the record of the teachings of the prior art, were not previously considered nor addressed during a prior examination and the same question of patentability was not the subject of a final holding of invalidity by Federal Courts.

Conclusion

Since Requester did not request reexamination of claims 3-7, 11-13, 15 and 17 and did not assert the existence of a substantial new question of patentability (SNQ) for such claims, these claims will not be reexamined unless at the discretion of the Office.

Extensions of time under 37 CFR 1.136(a) will not be permitted in these proceedings because the provisions of 37 CFR 1.136 apply only to "an applicant" and not to parties in a reexamination proceeding. Additionally, 35 U.S.C. 305 requires that ex parte reexamination proceedings "will be conducted with special dispatch" (37 CFR 1.550(a)). Extensions of time in

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ex parte reexamination proceedings are provided for in 37 CFR 1.550(c).

The patent owner is reminded of the continuing responsibility under 37 CFR 1.565(a) to apprise the Office of any litigation activity, or other prior or concurrent proceeding, involving Patent No 6,229,366 throughout the course of this reexamination proceeding. The third party requester is also reminded of the ability to similarly apprise the Office of any such activity or proceeding throughout the course of this reexamination proceeding. See MPEP §§ 2207, 2282 and 2286.

Please mail any communications to:

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Commissioner for Patents
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Alexandria VA 22313-1450

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Application/Control Number: 90/008,327

Page 11

Art Unit: 3992

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Attn: Central Reexamination Unit

Randolph Building, Lobby Level

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Alexandria, VA 22314

Any inquiry concerning this communication or earlier communications from the Reexamination Legal Advisor or Examiner, or as to the status of this proceeding, should be directed to the Central Reexamination Unit at telephone number (571) 272-7705.



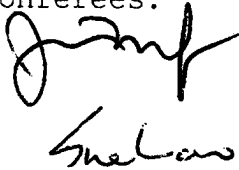
Margaret Rubin

Primary Examiner

Central Reexamination Unit 3992

(571) 272-1756

conferees:



71338 U.S. PTO
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Approved for use through 10/3/06
Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

PTO/SB/08A (10-96)

Substitute for form 1449A/PTO

Complete if Known 11/09/06

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(use as many sheets as necessary)

Sheet

1

of

1

Attorney Docket Number

Patent Number

6,229,366

Issue Date

May 8, 2001

First Named Inventor

Balu Balakirshnan

Group Art Unit

3992

Examiner Name

Rubin

U.S. PATENT DOCUMENTS

Examiner Initials	Cite No. ¹	U.S. Patent Document		Name of Patentee or Applicant of Cited Document	Date of Patent of Cited Documents MM-DD-YYYY
		Number	Kind Code ²		
MR	AA	4,638,417		Hubert C. Martin, Jr.	01/20/1987
	AB				

FOREIGN PATENT DOCUMENTS

Examiner Initials	Cite No. ¹	Foreign Patent Document			Name of Patentee or Applicant of Cited Document	Date of Publications of Cited Documents MM-DD-YYYY	T ⁴
		Office ³	Number ⁴	Kind Code ⁵			
	BA						

OTHER PRIOR ART - NON PATENT LITERATURE DOCUMENTS

Examiner Initials	Cite No. ¹	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ²
MR	CA	SGS-Thompson datasheet entitled "TEA2262, Switch Mode Power supply Controller," pp. 1-9 (April 1996) ("TEA2262").	
MR	CB	R. Keller, "Power Integrations," Off-Line Power Integrated Circuit for International Rated 60-Watt Power Supplies," (February 23-27, 1992) Keller pp 505 - 512	
MR	CC	"Programmed Pulsewidth Modulated Waveforms For Electromagnetic Interferences Mitigation In DC-DC Converters", IEEE Transactions on Power Electronics, Vol. 8, No. 4 (October 1993) A.C. Wang and S.R. Sanders ("Wang"). pp 596 - 605	
MR	CD	Unitrode UCC 3800/1/2/3/4/5 biCMOS Current Mode Control IC's (1994) ("U-133") pp 9-344 - 1943	

Bill Andreyca

Examiner Signature	M Rubin	Date Considered	1/3/07
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AMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 809. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

1. Unique citation designation number. 2. See attached Kinds of U.S. Patent Documents. 3. Enter Office that issued the document, by the two-letter code (WIPO Standard ST.). 4. For Japanese patent documents, indication of the year of the reign of the Emperor must precede the serial number of the patent documents. 5. Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. 6. Applicant is to place a check mark here if English language Translation is attached.

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EXHIBIT B



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
 United States Patent and Trademark Office
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
90/008,326	11/09/2006	6249876	10414-25	7651

7590

12/21/2006

EXAMINER

Bradley J. Bereznak, Esq.
 BLAKELY SOKOLOFF TAYLOR & ZAFMAN, LLP
 12400 Wilshire Blvd.
 Seventh Floor
 Los Angeles, CA 90025

ART UNIT

PAPER NUMBER

DATE MAILED: 12/21/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Order Granting / Denying Request For Ex Parte Reexamination	Control No.	Patent Under Reexamination	
	90/008,326	6249876	
	Examiner	Art Unit	
	Margaret Rubin	3992	

--The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

The request for *ex parte* reexamination filed 09 November 2006 has been considered and a determination has been made. An identification of the claims, the references relied upon, and the rationale supporting the determination are attached.

Attachments: a) ☐ PTO-892, b) ☒ PTO/SB/08, c) ☐ Other: _____

1. ☒ The request for *ex parte* reexamination is GRANTED.

RESPONSE TIMES ARE SET AS FOLLOWS:

For Patent Owner's Statement (Optional): TWO MONTHS from the mailing date of this communication (37 CFR 1.530 (b)). **EXTENSIONS OF TIME ARE GOVERNED BY 37 CFR 1.550(c).**

For Requester's Reply (optional): TWO MONTHS from the date of service of any timely filed Patent Owner's Statement (37 CFR 1.535). **NO EXTENSION OF THIS TIME PERIOD IS PERMITTED.** If Patent Owner does not file a timely statement under 37 CFR 1.530(b), then no reply by requester is permitted.

2. ☐ The request for *ex parte* reexamination is DENIED.

This decision is not appealable (35 U.S.C. 303(c)). Requester may seek review by petition to the Commissioner under 37 CFR 1.181 within ONE MONTH from the mailing date of this communication (37 CFR 1.515(c)). **EXTENSION OF TIME TO FILE SUCH A PETITION UNDER 37 CFR 1.181 ARE AVAILABLE ONLY BY PETITION TO SUSPEND OR WAIVE THE REGULATIONS UNDER 37 CFR 1.183.**

In due course, a refund under 37 CFR 1.26 (c) will be made to requester:

- a) ☐ by Treasury check or,
b) ☐ by credit to Deposit Account No. _____, or
c) ☐ by credit to a credit card account, unless otherwise notified (35 U.S.C. 303(c)).

Margaret Rubin
Primary Examiner
Art Unit: 3992

cc:Requester (if third party requester)

Application/Control Number: 90/008,326
Art Unit: 3992

Page 2

DECISION GRANTING EX PARTE REEXAMINATION

Summary

Substantial new questions of patentability affecting claims 1 and 17-19 of United States Patent No. 6,249,876 (hereafter "the base patent") are raised by the following references:

- 1.) Acoustic Noise Reduction in Sinusoidal PWM Drives Using A Randomly Modulated Carrier", IEEE Transactions on Power Electronics, Vol. 6, No. 3, p.356-363 (published July 1991) by T.G. Habetler and D. M. Divan (hereafter "Habetler");
- 2.) U.S. Patent No. 4,638,417 to Martin; and
- 3.) "Programmed Pulsewidth Modulated Waveforms for Electromagnetic Interference Mitigation in DC-DC Converters"; IEEE Transactions on Power Electronics, Vol. 8, No.4 (October 1993) by A.C. Wang and S.R. Sanders, pp. 596-605 (hereafter "Wang").

Issues Raised by Requester

Application/Control Number: 90/008,326

Page 3

Art Unit: 3992

Although the merits of the rejections suggested in the request are not decided herein, it is noted that the Requester proposes that the references supplied raise substantial new questions of patentability when viewed in the following manner:

- 1.) Claim 1 is anticipated by Martin;
- 2.) Claims 1, 17, 18, and 19 are anticipated by Habetler; and
- 3.) Claim 1 is anticipated by Wang.

Background

The base patent issued from United States Patent Application No. 09/192,959 (hereafter "the base application"). It is noted that the non-final rejection dated October 16, 2000 states that claims 1-10 included allowable subject matter but reasons therefor were not provided. Further, the Notice of Allowance mailed January 20, 2001 did not include a Statement of Reasons for Allowance.

In summary, the prosecution history does not provide a clear record of the reasons the base patent was allowed.

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Issues

Martin

It is agreed that Martin raises an SNQ for claim 1. More particularly, Requester has provided plausible item-matching for a number of limitations of claim 1 on pages 7-10 of the request. In view of the fact that the prosecution history does not provide a clear record of the reasons the base patent was allowed, the teachings presented in the request cannot be judged as merely cumulative.

Such teachings are not cumulative to any written discussion on the record of the teachings of the prior art, were not previously considered nor addressed during a prior examination and the same question of patentability was not the subject of a final holding of invalidity by Federal Courts.

Wang

It is agreed that Wang raises an SNQ for claim 1. More particularly, Requester has provided plausible item-matching for a number of limitations of claim 1 on pages 21-23 of the request. In view of the fact that the prosecution history does

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Page 5

Art Unit: 3992

not provide a clear record of the reasons the base patent was allowed, the teachings presented in the request cannot be judged as merely cumulative.

Such teachings are not cumulative to any written discussion on the record of the teachings of the prior art, were not previously considered nor addressed during a prior examination and the same question of patentability was not the subject of a final holding of invalidity by Federal Courts.

Habetler

It is agreed that Habetler raises an SNQ for claim 1, 17, 18, and 19. More particularly, Requester has provided plausible item-matching for a number of limitations of claim 1 and 17 on pages 12-16 of the request. In view of the fact that the prosecution history does not provide a clear record of the reasons the base patent was allowed, the teachings presented in the request cannot be judged as merely cumulative. By raising an SNQ with regard to independent claim 17, an SNQ is also raised for the dependent claims 18-19 which come freighted with the limitations of the claim from which they stem.

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Such teachings are not cumulative to any written discussion on the record of the teachings of the prior art, were not previously considered nor addressed during a prior examination and the same question of patentability was not the subject of a final holding of invalidity by Federal Courts.

Conclusion

Since Requester did not request reexamination of claims 2-16 and 20-32 and did not assert the existence of a substantial new question of patentability (SNQ) for such claims, these claims will not be reexamined unless at the discretion of the Office.

Extensions of time under 37 CFR 1.136(a) will not be permitted in these proceedings because the provisions of 37 CFR 1.136 apply only to "an applicant" and not to parties in a reexamination proceeding. Additionally, 35 U.S.C. 305 requires that *ex parte* reexamination proceedings "will be conducted with special dispatch" (37 CFR 1.550(a)). Extensions of time in *ex parte* reexamination proceedings are provided for in 37 CFR 1.550(c).

Application/Control Number: 90/008,326

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Art Unit: 3992

The patent owner is reminded of the continuing responsibility under 37 CFR 1.565(a) to apprise the Office of any litigation activity, or other prior or concurrent proceeding, involving Patent No 6,249,876 throughout the course of this reexamination proceeding. The third party requester is also reminded of the ability to similarly apprise the Office of any such activity or proceeding throughout the course of this reexamination proceeding. See MPEP §§ 2207, 2282 and 2286.

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Application/Control Number: 90/008,326

Page 8

Art Unit: 3992

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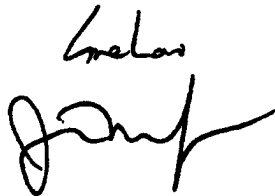
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Margaret Rubin
Primary Examiner
Central Reexamination Unit 3992
(571) 272-1756

conferees:



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71338 U.S. PTO

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Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

PTO/SB/08A (10-95)

71338 U.S. PTO

01/06/06

01/06/06

11/09/06		449A/PTO		Complete if Known		11/09/06	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (use as many sheets as necessary)				Patent Number	6,249,876		
				Issue Date	June 19, 2001		
				First Named Inventor	Balu Balakrishnan		
				Group Art Unit	3992		
				Examiner Name	Rubin		
Sheet	1	of	1	Attorney Docket Number	10414-25		

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No. ¹	U.S. Patent Document		Name of Patentee or Applicant of Cited Document	Date of Patent of Cited Documents MM-DD-YYYY
		Number	Kind Code ²		
MR	AA	4,638,417		Hubert C. Martin, Jr., et al.	January 20, 1987
	AB				

FOREIGN PATENT DOCUMENTS							
Examiner Initials	Cite No. ¹	Foreign Patent Document			Name of Patentee or Applicant of Cited Document	Date of Publications of Cited Documents MM-DD-YYYY	T ⁶
		Office ³	Number ⁴	Kind Code ⁵			
	BA						

OTHER PRIOR ART - NON PATENT LITERATURE DOCUMENTS					
Examiner Initials	Cite No. ¹	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.			T ²
MR	CA	Programmed Pulsewidth Modulated Waveforms For Electromagnetic Interference Mitigation In DC-DC Converters", IEEE Transactions on Power Electronics, Vol. 8, No. 4 (published October 1993) by A.C. Wang and S. R. Sanders ("Wang and Sanders") <i>pages 596-605</i>			
MR	CB	Acoustic Noise Reduction In Sinusoidal PWM Drives Using A Randomly Modulated Carrier", IEEE Transactions on Power Electronics, Vol. 6, No. 3, p. 356 (published July 1991) by T.G. Habetler and D.M. Divan ("Habetler and Divan") <i>through p.363</i>			
	CC				

Examiner Signature	<i>MR</i>	Date Considered	12/18/06
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¹EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 608. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Unique citation designation number. ²See attached Kinds of U.S. Patent Documents. ³Enter Office that issued the document, by the two-letter code (WIPO Standard ST.). ⁴For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent documents. ⁵Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. ⁶Applicant is to place a check mark here if English language Translation is attached.

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EXHIBIT C



UNITED STATES PATENT AND TRADEMARK OFFICE

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 Alexandria, Virginia 22313-1450
 www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
90/008,324	11/09/2006	6107851	10414-25	6695

7590 12/19/2006

BRADLEY J. BEREZNAK, EQS.
 BLAKELEY, SOKOLOFF, TAYLOR, ZAFMAN LLP.
 12400 WILSHIRE BOULEVARD
 SEVENTH FLOOR
 LOS ANGELES, CA 90025

EXAMINER

ART UNIT

PAPER NUMBER

DATE MAILED: 12/19/2006

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12/19/06

THIRD PARTY REQUESTER'S CORRESPONDENCE ADDRESS

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EX PARTE REEXAMINATION COMMUNICATION TRANSMITTAL FORM

REEXAMINATION CONTROL NO 90/008324
PATENT NO. 6,107,851
ART UNI 3992

Enclosed is a copy of the latest communication from the United States Patent and Trademark Office in the above identified ex parte reexamination proceeding (37 CFR 1.550(f)).

Where this copy is supplied after the reply by requester, 37 CFR 1.535, or the time for filing a reply has passed, no submission on behalf of the ex parte reexamination requester will be acknowledged or considered (37 CFR 1.550(g)).

Order Granting / Denying Request For Ex Parte Reexamination	Control No.	Patent Under Reexamination	
	90/008,324	6107851	
	Examiner	Art Unit	
	Margaret Rubin	3992	

--The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

The request for *ex parte* reexamination filed 09 November 2006 has been considered and a determination has been made. An identification of the claims, the references relied upon, and the rationale supporting the determination are attached.

Attachments: a) ☐ PTO-892, b) ☒ PTO/SB/08, c) ☐ Other: _____

1. ☒ The request for *ex parte* reexamination is GRANTED.

RESPONSE TIMES ARE SET AS FOLLOWS:

For Patent Owner's Statement (Optional): TWO MONTHS from the mailing date of this communication (37 CFR 1.530 (b)). **EXTENSIONS OF TIME ARE GOVERNED BY 37 CFR 1.550(c).**

For Requester's Reply (optional): TWO MONTHS from the **date of service** of any timely filed Patent Owner's Statement (37 CFR 1.535). **NO EXTENSION OF THIS TIME PERIOD IS PERMITTED.** If Patent Owner does not file a timely statement under 37 CFR 1.530(b), then no reply by requester is permitted.

2. ☐ The request for *ex parte* reexamination is DENIED.

This decision is not appealable (35 U.S.C. 303(c)). Requester may seek review by petition to the Commissioner under 37 CFR 1.181 within ONE MONTH from the mailing date of this communication (37 CFR 1.515(c)). **EXTENSION OF TIME TO FILE SUCH A PETITION UNDER 37 CFR 1.181 ARE AVAILABLE ONLY BY PETITION TO SUSPEND OR WAIVE THE REGULATIONS UNDER 37 CFR 1.183.**

In due course, a refund under 37 CFR 1.26 (c) will be made to requester:

- a) ☐ by Treasury check or,
b) ☐ by credit to Deposit Account No. _____, or
c) ☐ by credit to a credit card account, unless otherwise notified (35 U.S.C. 303(c)).

Margaret Rubin
Primary Examiner
Art Unit: 3992

cc:Requester (if third party requester)

Application/Control Number: 90/008,324
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DECISION GRANTING EX PARTE REEXAMINATION

Information Submissions

Information Submissions in *Ex Parte* Proceedings are bound by 37 CFR § 1.555 which incorporates 37 CFR § 1.98(a). Establishing a publication date for non-patent literature is among the requirements of 37 CFR § 1.98(a). Insofar as Requester has not provided the same for citation CE, this reference has not been considered and has been lined through on the information disclosure statement. Furthermore, it appears as if Requester made a typographical error in transcribing the title of citation CB and page numbers were not supplied for citations CC and CD. Corrections have been made by the Office on PTO form 1449.

Summary

Substantial new questions of patentability affecting claims 1, 2, 4, 7, 9, 10, 11, 13, 16 and 17 of United States Patent No.

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6,107,851 (hereafter "the base patent") are raised by the following references¹:

¹ An SNQ is not raised by LM3101 Secondary-Side PWM Controller; National Semiconductor, cite "CE" of the IDS, because Requester has not established that a publication date for the document. Thus, whether it qualifies as prior art under 35 USC 102 is unknown.

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- 1.) SGS-Thomson TEA 2262 Datasheet, "Switch Mode Power Supply Controller", pp 1-9, (April 1996) (hereafter, "TEA 2262");
- 2.) SGS-Thomson TEA 2260/TEA2261, Datasheet Application Note 376, "High Performance Driver Circuits for S.M.P.S." pp. 1-33 (June 1994) (hereafter, "TEA 2260/2261");
- 3.) PWM Power Supply IC; 85-265 VAC Input Isolated, Regulated DC Output, Power Integrations SMP211 Datasheet (January 1996) (hereafter, "SMP 211");
- 4.) U.S. Patent No. 4,638,417 to Martin;
- 5.) "Programmed Pulsewidth Modulated Waveforms for Electromagnetic Interference Mitigation in DC-DC Converters"; IEEE Transactions on Power Electronics, Vol. 8, No.4 (October 1993) by A.C. Wang and S.R. Sanders, pp. 596-605 (hereafter "Wang");
- 6.) U.S. Patent No. 5,498,995 to Szepesi et al., (hereafter "Szepesi"); and
- 7.) "Off-Line Power Integrated Circuit for International Rated 60-watt Power Supplies" by Richard Keller, Applied Power Electronics Conference and Exposition, February 1992 (pp. 505-512) (hereafter, "Keller").

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Issues Raised by Requester

Although the merits of the rejections suggested in the request are not decided herein, it is noted that the Requester proposes that the references supplied raise substantial new questions of patentability when viewed in the following manner:

- 1.) Claims 1, 2, 4, 7, 9, 10, 11, 13, 16 and 17 are rejected under 35 U.S.C. §§102(a)(b) as anticipated by TEA 2262;
- 2.) Claims 1, 2, 4, 7, 9, 10, 11, 13, 16, and 17 are rejected under 35 U.S.C. §§102(a)(b) as anticipated by SMP211 in light of the admitted prior art of the patent;
- 3.) Claims 1, 2, 7, 9, 10, 11, 16, and 17 are rejected under 35 U.S.C. §§102(a)(b) as anticipated by Martin;
- 4.) Claims 1, 2, 7, 9, 10, 11, 16, and 17 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Martin in view of SMP211;
- 5.) Claims 4 and 13 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Martin in view of Keller;
- 6.) Claims 1, 2, 7, 9, 10, 11, 16, and 17 are rejected under 35 U.S.C. §§102(a)(b) as anticipated by Wang;

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7.) Claims 4 and 13 are rejected under 35 U.S.C. §103(a) as being unpatentable over Wang in view of Keller; and

8.) Claims 1, 2, 7, 9, 10, 11, 16, and 17 are rejected under 35 U.S.C. §§102(a)(b) as anticipated by Szepesi.

Background

The base patent issued from United States Patent Application No. 09/080,774 (hereafter "the base application"). Although Office records of the prosecution history of the base application are not currently available and will not be available in a timely manner for purposes of deciding this request, insofar as Requester has provided papers from the prosecution history, they have been reviewed to determine what claim limitations were deemed patentable. It is noted that a statement regarding allowable subject matter dated December 13, 1999 cited "a PWM switch comprising an oscillator [sic] for generating a maximum duty cycle signal and a singnal [sic] with a frequency range dependent on a frequency variation circuit as recited in claim 1." It is noted that there are two independent claims within the base patent: claims 1 and 11. Neither of them include recitation of a signal with a frequency range dependent on a frequency variation circuit. In addition, claim 11 does not

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require a PWM switch. Lastly, from the records supplied by Requester, it appears as if a Statement of Reasons for Allowance was not made when the base application was allowed.

In summary, the prosecution history does not provide a clear record of the reasons the base patent was allowed.

Issues

TEA 2262 and TEA 2260/2261

It is agreed that TEA 2262 and TEA 2260/2261 raise an SNQ for claims 1 and 11. Insofar as Requester has grouped these references together for presentation, they have been evaluated together herein. (That said, these references could not fairly be treated as a single publication for purposes of making a rejection under 35 USC 102 as suggested by Requester.) More particularly, Requester has provided plausible item-matching for a number of limitations of claims 1 and 11 on pages 10-15 and 20-26, respectively, of the request. In view of the fact that the prosecution history does not provide a clear record of the reasons the base patent was allowed, the teachings presented in the request cannot be judged as merely cumulative. By raising an SNQ with regard to the independent claims, an SNQ is also raised

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for the dependent claims 2, 4, 7, 9, 10, 13, 16 and 17 which come freighted with the limitations of the claims from which they stem.

Such teachings are not cumulative to any written discussion on the record of the teachings of the prior art, were not previously considered nor addressed during a prior examination and the same question of patentability was not the subject of a final holding of invalidity by Federal Courts.

SMP211

It is agreed that SMP 211 raises an SNQ for claims 1 and 11. More particularly, Requester has provided plausible item-matching for a number of limitations of claims 1 and 11 on pages 31-34 and 39-42, respectively, of the request. In view of the fact that the prosecution history does not provide a clear record of the reasons the base patent was allowed, the teachings presented in the request cannot be judged as merely cumulative. By raising an SNQ with regard to the independent claims, an SNQ is also raised for claims 2, 4, 7, 9, 10, 11, 13, 16 and 17 which come freighted with the limitations of the claims from which they stem.

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Such teachings are not cumulative to any written discussion on the record of the teachings of the prior art, were not previously considered nor addressed during a prior examination and the same question of patentability was not the subject of a final holding of invalidity by Federal Courts.

Martin

It is agreed that Martin raises an SNQ for claims 1 and 11. More particularly, Requester has provided plausible item-matching for a number of limitations of claims 1 and 11 on pages 46-49 and 55-59, respectively, of the request. In view of the fact that the prosecution history does not provide a clear record of the reasons the base patent was allowed, the teachings presented in the request cannot be judged as merely cumulative. By raising an SNQ with regard to the independent claims, an SNQ is also raised for claims 2, 4, 7, 9, 10, 13, 16 and 17 which come freighted with the limitations of the claims from which they stem.

Such teachings are not cumulative to any written discussion on the record of the teachings of the prior art, were not previously considered nor addressed during a prior examination

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and the same question of patentability was not the subject of a final holding of invalidity by Federal Courts.

Keller

It is agreed that Keller raises an SNQ for claims 4 and 13. More particularly, Requester has provided plausible item-matching for a number of limitations of claims 4 and 13 at least on pages 50-51 and 59-60, respectively, of the request. In view of the fact that the prosecution history does not provide a clear record of the reasons the base patent was allowed, the teachings presented in the request cannot be judged as merely cumulative.

Such teachings are not cumulative to any written discussion on the record of the teachings of the prior art, were not previously considered nor addressed during a prior examination and the same question of patentability was not the subject of a final holding of invalidity by Federal Courts.

Wang

It is agreed that Wang raises an SNQ for claims 1 and 11. More particularly, Requester has provided plausible item-

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matching for a number of limitations of claims 1 and 11 on pages 67-70 and 75-79, respectively, of the request. In view of the fact that the prosecution history does not provide a clear record of the reasons the base patent was allowed, the teachings presented in the request cannot be judged as merely cumulative. By raising an SNQ with regard to the independent claims, an SNQ is also raised for claims 2, 4, 7, 9, 10, 11, 13, 16 and 17 which come freighted with the limitations of the claims from which they stem.

Such teachings are not cumulative to any written discussion on the record of the teachings of the prior art, were not previously considered nor addressed during a prior examination and the same question of patentability was not the subject of a final holding of invalidity by Federal Courts.

Szepesi

It is agreed that Szepesi raises an SNQ for claims 1 and 11. More particularly, Requester has provided plausible item-matching for a number of limitations of claims 1 and 11 on pages 84-89 and 94-100, respectively, of the request. In view of the fact that the prosecution history does not provide a clear record of the reasons the base patent was allowed, the teachings

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presented in the request cannot be judged as merely cumulative. By raising an SNQ with regard to the independent claims, an SNQ is also raised for claims 2, 4, 7, 9, 10, 11, 13, 16 and 17 which come freighted with the limitations of the claims from which they stem.

Such teachings are not cumulative to any written discussion on the record of the teachings of the prior art, were not previously considered nor addressed during a prior examination and the same question of patentability was not the subject of a final holding of invalidity by Federal Courts.

Conclusion

Since Requester did not request reexamination of claims 3, 5, 6, 8, 12, 14, 15 and 18 and did not assert the existence of a substantial new question of patentability (SNQ) for such claims, these claims will not be reexamined unless at the discretion of the Office.

Extensions of time under 37 CFR 1.136(a) will not be permitted in these proceedings because the provisions of 37 CFR 1.136 apply only to "an applicant" and not to parties in a reexamination proceeding. Additionally, 35 U.S.C. 305 requires

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that ex parte reexamination proceedings "will be conducted with special dispatch" (37 CFR 1.550(a)). Extensions of time in ex parte reexamination proceedings are provided for in 37 CFR 1.550(c).

The patent owner is reminded of the continuing responsibility under 37 CFR 1.565(a) to apprise the Office of any litigation activity, or other prior or concurrent proceeding, involving Patent No 6,107,851 throughout the course of this reexamination proceeding. The third party requester is also reminded of the ability to similarly apprise the Office of any such activity or proceeding throughout the course of this reexamination proceeding. See MPEP §§ 2207, 2282 and 2286.

Please mail any communications to:

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Commissioner for Patents
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Alexandria VA 22313-1450

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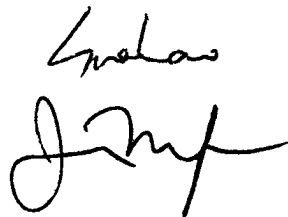
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401 Dulany Street
Alexandria, VA 22314

Any inquiry concerning this communication or earlier communications from the Reexamination Legal Advisor or Examiner, or as to the status of this proceeding, should be directed to the Central Reexamination Unit at telephone number (571) 272-7705.



Margaret Rubin
Primary Examiner
Central Reexamination Unit 3992
(571) 272-1756

conferees:



Please type a plus sign (+) in this box ☐

PTO/SB/08A (10-96)

Approved for use through 10/31/99. OMB 0851-0031

Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Substitute for form 1449A/PTO		Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (use as many sheets as necessary)		Patent Number	6,107,851
		Issue Date	June 19, 2001
		First Named Inventor	Balu Balakrishnan
		Group Art Unit	3992
		Examiner Name	Rubin
Sheet 1 of 1	Attorney Docket Number		

U.S. PATENT DOCUMENTS					
Examiner Initials	Cite No. ¹	U.S. Patent Document		Name of Patentee or Applicant of Cited Document	Date of Patent of Cited Documents MM-DD-YYYY
		Number	Kind Code ²		
MR	AA	4,638,417		Hubert C. Martin, Jr., et al.	January 20, 1987
MR	AB	5,498,995		Thomas Szepesi	March 12, 1996

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Examiner Initials	Cite No. ¹	Foreign Patent Document			Name of Patentee or Applicant of Cited Document	Date of Publications of Cited Documents MM-DD-YYYY	T ⁶
		Office ³	Number ⁴	Kind Code ⁵			
	BA						

OTHER PRIOR ART - NON PATENT LITERATURE DOCUMENTS			
Examiner Initials	Cite No. ¹	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ²
MR	CA	SGS-Thomson Microelectronics TEA 2262; Switch Mode Power Supply Controller; pages 1-9; April 1996	
MR	CB	SGS-Thomson Microelectronics TEA 2262/TEA2261; High Performance Driver Circuits for S.M.P.S.; pages 1-33; June 1994	
MR	CC	PWM Power Supply IC; 85-265 VAC Input Isolated, Regulated DC Output; Power Integrations SMP211 Datasheet (January 1996) ("SMP 211") pp 2-46 to 2-58 and pp 5-1 to 5-6	
MR	CD	"Programmed Pulsewidth Modulated Waveforms for Electromagnetic Interference Mitigation in DC-DC Converters; IEEE Transactions on Power Electronics, Vol. 8, No. 4 (Oct 1993) A.C. Wang, S.R. Sanders	
	CE	LM3101 Secondary Side PWM Controller; National Semiconductor; Szepesi	
MR	CF	Off-Line Power Integrated Circuit For International Rated 60 Watt Power Supplies; Richard Keller, Power Integrations Inc. Page 505-512, IEEE 1992	

Examiner Signature	OHS West:260122431.1	Date Considered	12/8/06
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XAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹Unique citation designation number. ²See attached Kinds of U.S. Patent Documents. ³Enter Office that issued the document, by the two-letter code (WIPO Standard ST.). ⁴For Japanese patent documents, indicate the year of the reign of the Emperor must precede the serial number of the patent documents. ⁵Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. ⁶Applicant is to place a check mark here if English language Translation is attached.

Open Hour Statement: This form is estimated to take 2.0 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS, SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.

EXHIBIT D



US006229366B1

(12) **United States Patent**
Balakirshnan et al.

(10) Patent No.: **US 6,229,366 B1**
(45) Date of Patent: **May 8, 2001**

(54) **OFF-LINE CONVERTER WITH
INTEGRATED SOFTSTART AND
FREQUENCY JITTER**

(75) Inventors: **Balu Balakirshnan; Alex Djenguerian,**
both of Saratoga; **Lef Lund,** San Jose,
all of CA (US)

(73) Assignee: **Power Integrations, Inc.,** Sunnyvale,
CA (US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/573,081**

(22) Filed: **May 16, 2000**

Related U.S. Application Data

(62) Division of application No. 09/080,774, filed on May 18,
1998, now Pat. No. 6,107,851.

(51) Int. Cl.⁷ **H03K 3/017**

(52) U.S. Cl. **327/172; 327/143; 327/531;
327/544**

(58) Field of Search **327/142, 143,
327/172, 173, 174, 175, 176, 530, 531,
544**

(56) **References Cited**

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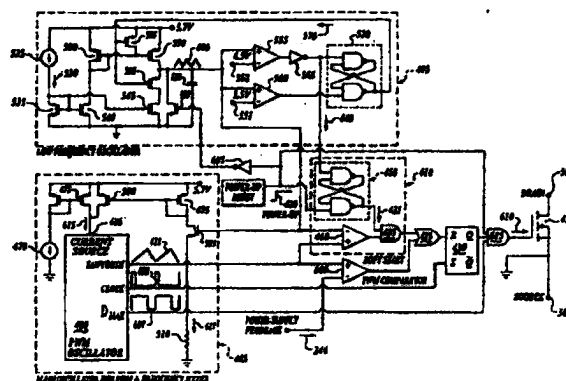
Primary Examiner—Jeffrey Zweig

(74) Attorney, Agent, or Firm—Blakely Sokoloff Taylor &
Zafman, LLP

(57) **ABSTRACT**

A pulse width modulated switch comprises a first terminal,
a second terminal, and a switch that allows a signal to be
transmitted between the first terminal and the second termi-
nal according to a drive signal provided at a control input.
The pulse width modulated switch also comprises a fre-
quency variation circuit that provides a frequency variation
signal and an oscillator that provides an oscillation signal
having a frequency of that varies within a frequency range
according to the frequency variation signal. The oscillator
further provides a maximum duty cycle signal comprising a
first state and a second state. The pulse width modulated
switch further comprises a drive circuit that provides the
drive signal when the maximum duty cycle signal is in the
first state and a magnitude of the oscillation signal is below
a variable threshold level.

18 Claims, 9 Drawing Sheets



Case No. 04-1371-JJF

DEFT Exhibit No. DX 103

Date Entered _____

Signature _____

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FCS0000208

U.S. Patent

May 8, 2001

Sheet 1 of 9

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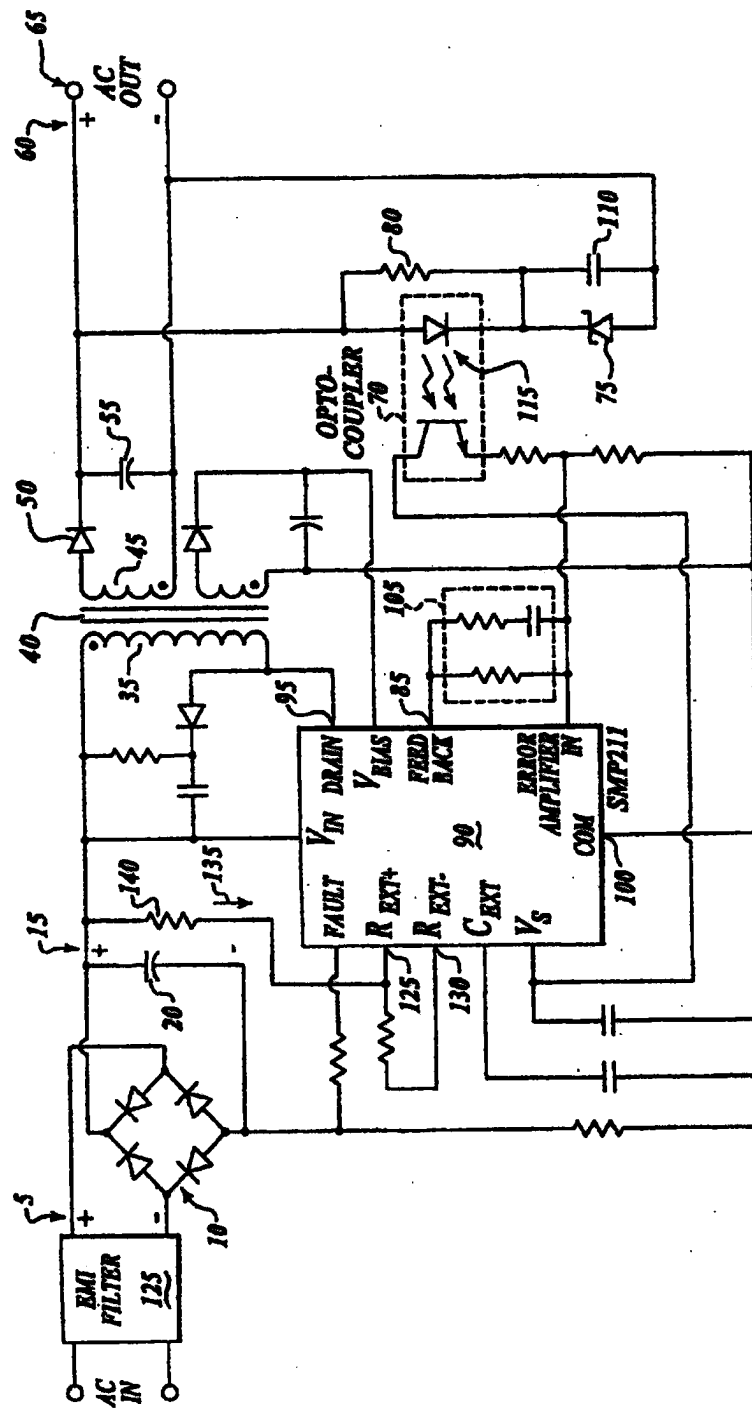


Fig. 1 (PRIOR ART)

FCS0000209

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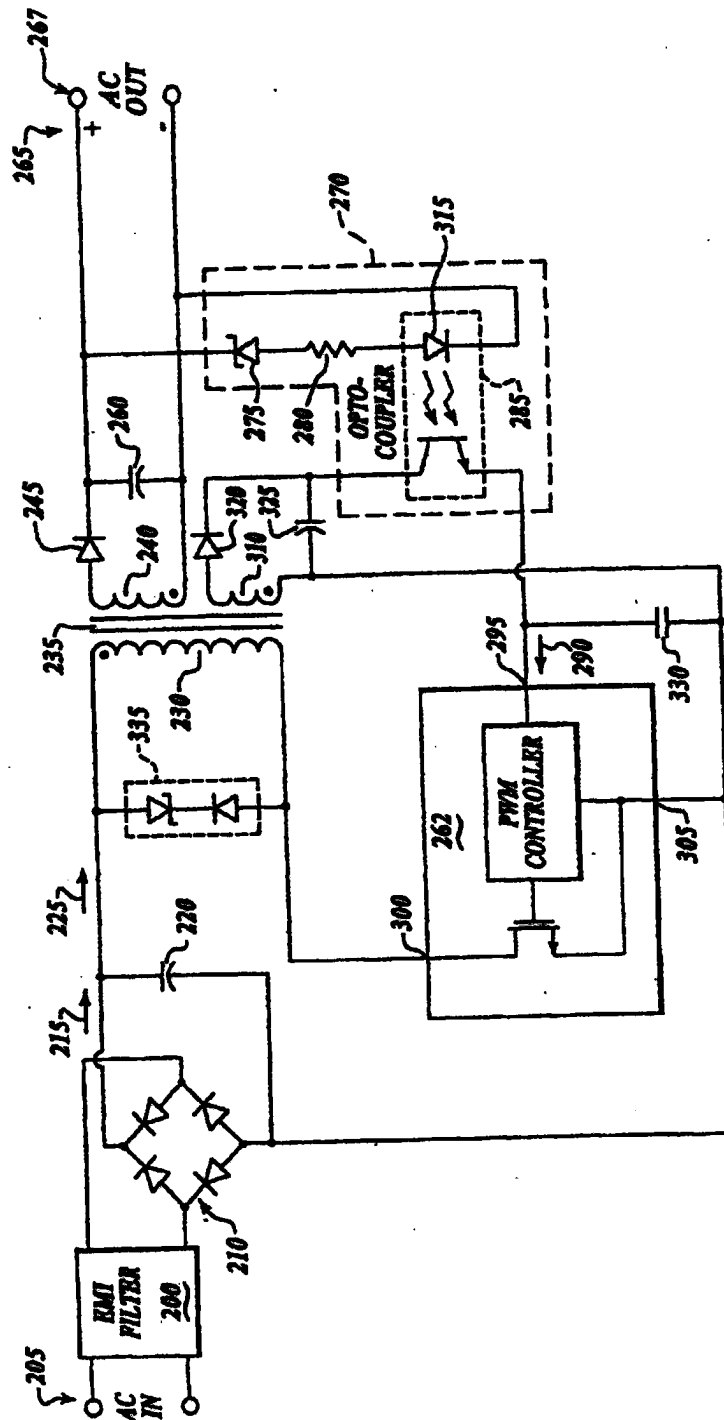


Fig. 2

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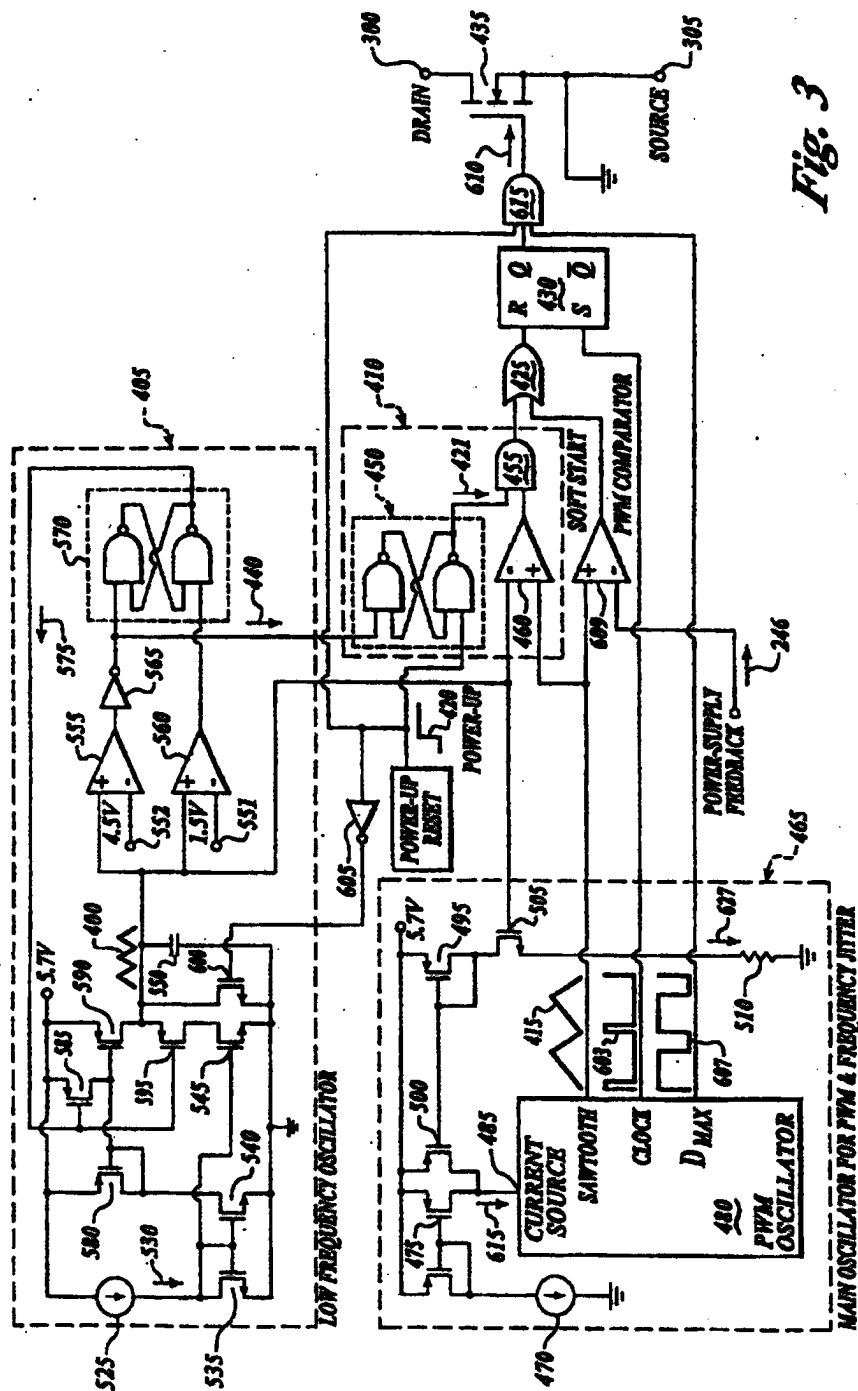


Fig. 3

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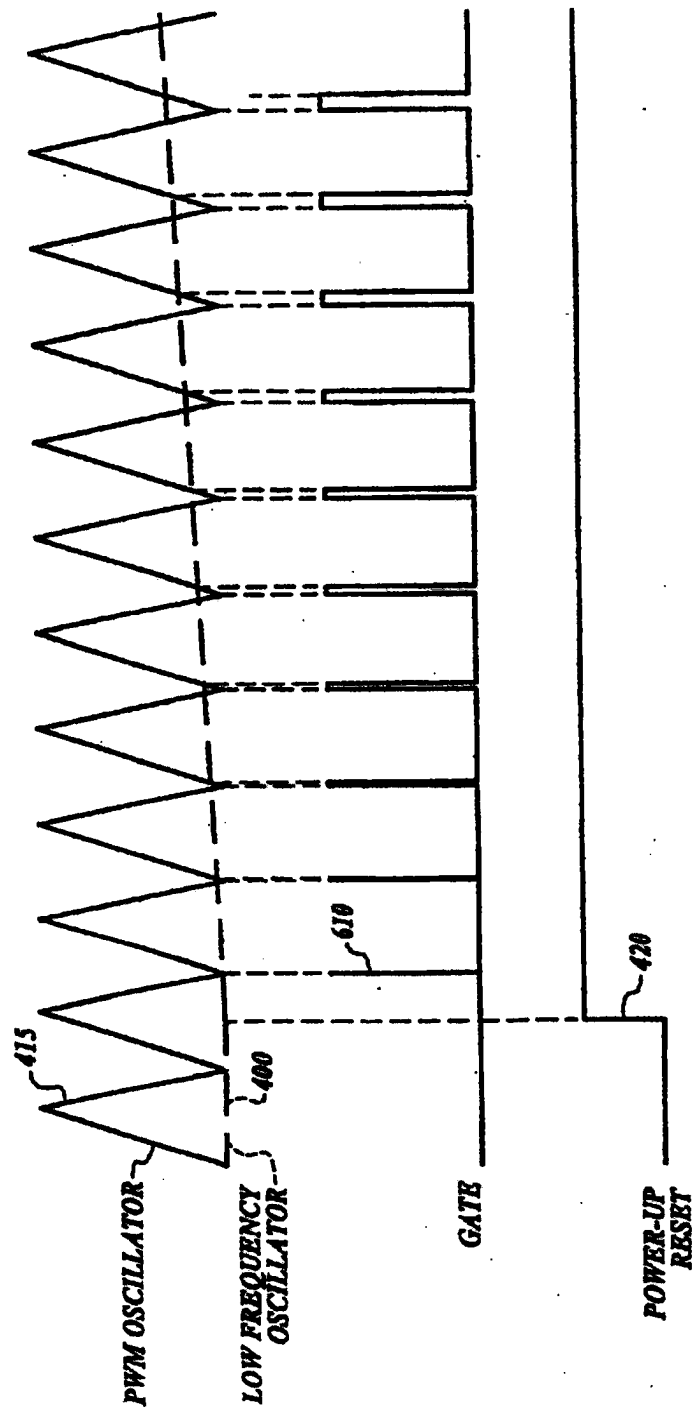


Fig. 4

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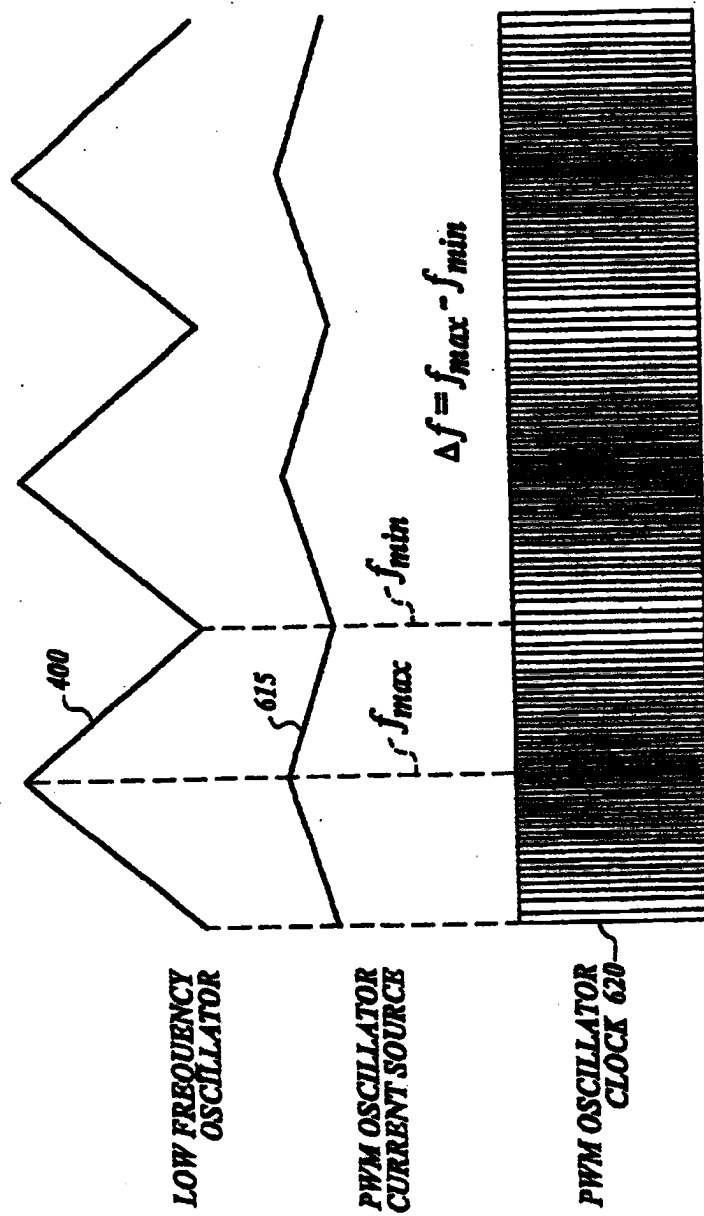


Fig. 5

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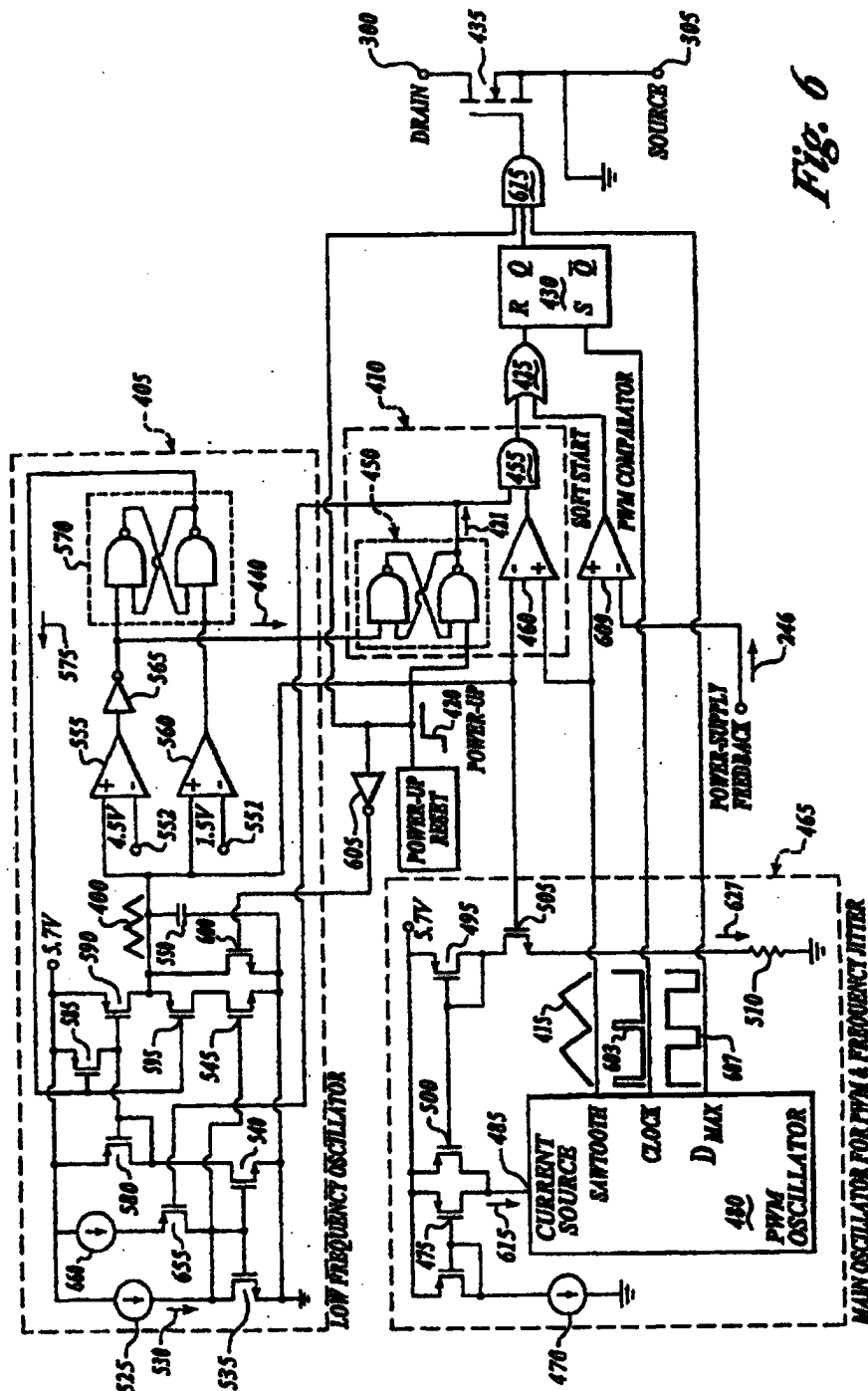


Fig. 6

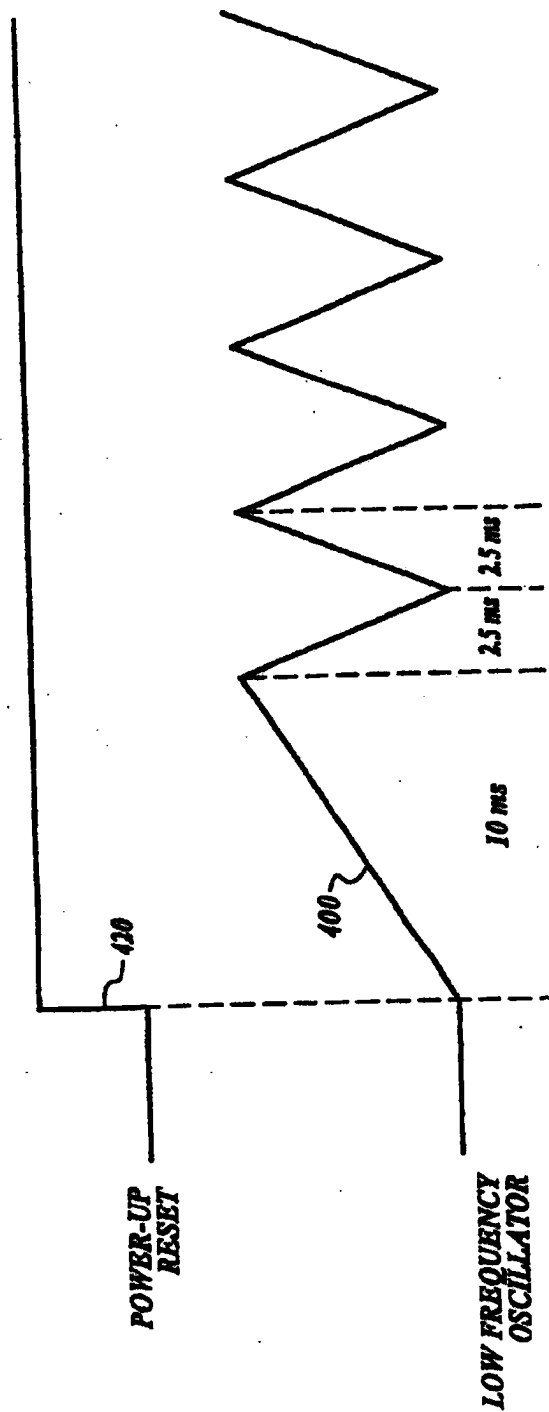
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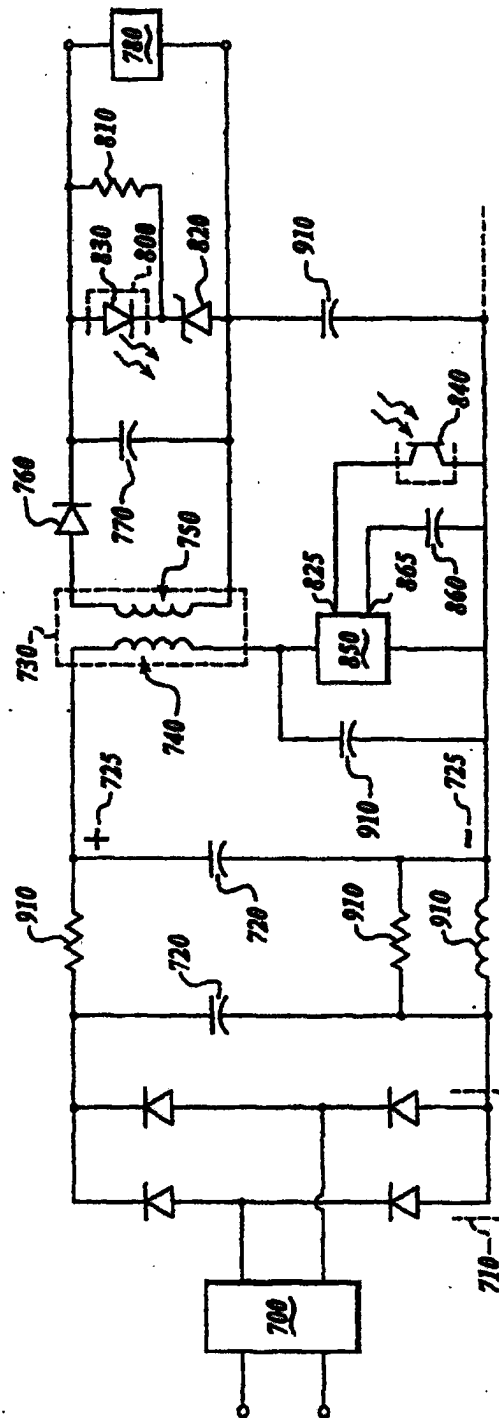


Fig. 8

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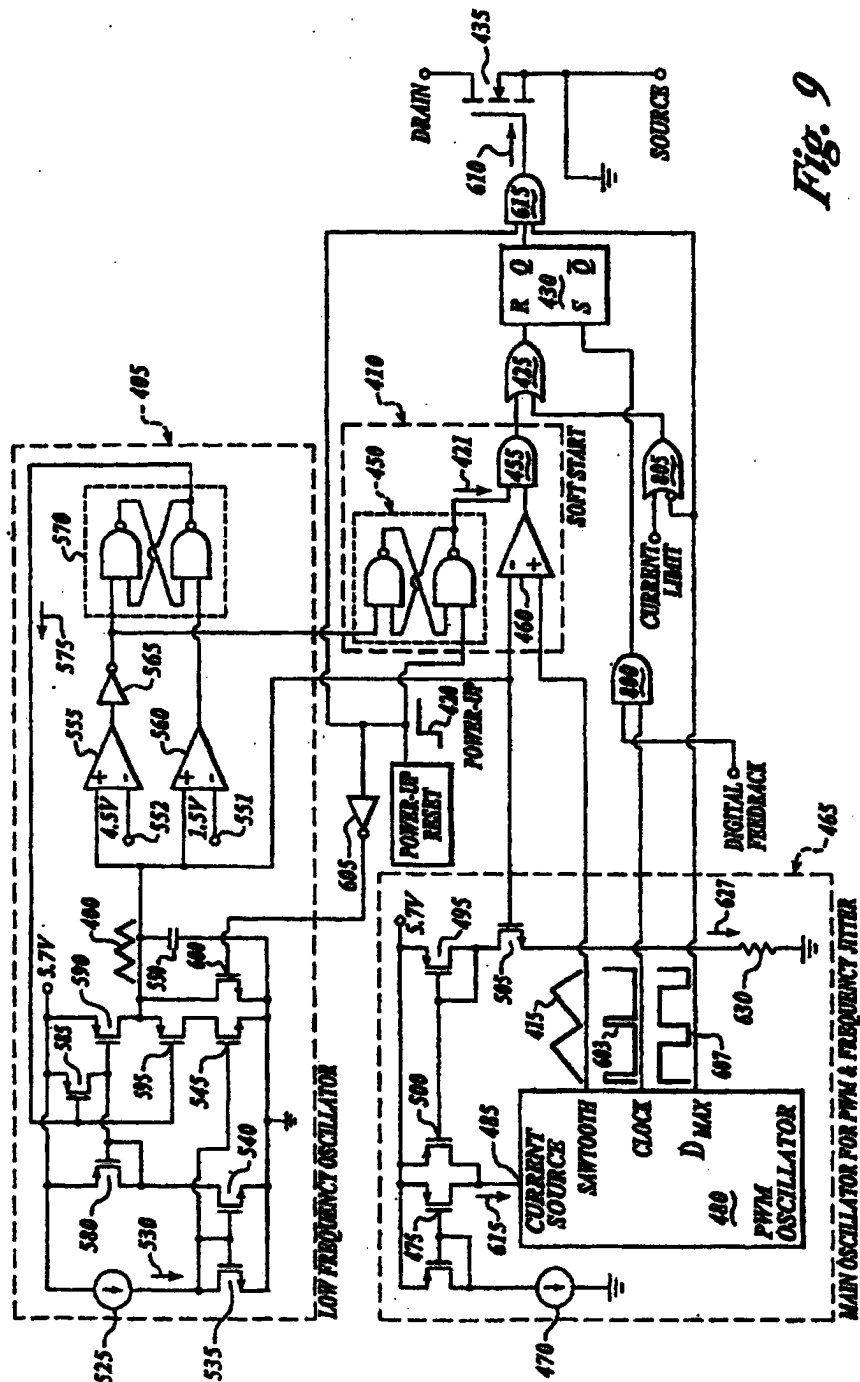


Fig. 9

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OFF-LINE CONVERTER WITH INTEGRATED SOFTSTART AND FREQUENCY JITTER

CROSS-REFERENCE TO RELATED APPLICATION

This is a Divisional of U.S. application Ser. No. 09/080,774, filed May 18, 1998, now U.S. Pat. No. 6,107,851.

BACKGROUND

1. Field of the Invention

The field of the present invention pertains to the field of power supplies and among other things to the regulation of power supplies.

2. Background of the Invention

Power supplies that convert an AC mains voltage to a DC voltage for use by integrated electronic devices, amongst other devices, are known. The power supplies are required to maintain the output voltage, current or power within a regulated range for efficient and safe operation of the electronic device. Switches that operate according to a pulse width modulated control to maintain the output voltage, current, or power of the power supply within a regulated range are also known. These switches utilize an oscillator and related circuitry to vary the switching frequency of operation of the switch, and therefore regulated the power, current or voltage that is supplied by the power supply.

A problem with utilizing pulse width modulated switches is that they operate at a relatively high frequency compared to the frequency of the AC mains voltage, which results in a high frequency signal being generated by the power supply. This high frequency signal is injected back into the AC mains input and becomes a component of the AC mains signal. The high frequency signals are also radiated by the power supply as electromagnetic waves. These high frequency signals add to the Electromagnetic Interference (EMI) of the power supply, and in fact are the largest contributors to the EMI of the power supply. The EMI generated by the power supply can cause problems for communications devices in the vicinity of the power supply and the high frequency signal which becomes a component of the AC mains signal will be provided to other devices in the power grid which also causes noise problems for these devices. Further, the radiated EMI by the power supply can interfere with radio and television transmissions that are transmitted over the air by various entities.

To combat the problem of EMI, several specifications have been developed by the Federal Communications Commission (FCC) in the United States and the European Community (EC) have established specification that specify the maximum amount of EMI that can be produced by classes of electronic devices. Since power supplies generate a major component of the EMI for electronic devices, an important step in designing a power supply is minimizing the EMI provided by the power supply to levels with the acceptable limits of the various standards. Since, a power supply can be utilized in many different countries of the world, the EMI produced should be within the most stringent limits worldwide to allow for maximum utilization of the power supply.

A known way of minimizing the EMI provided by the power supply is by adding an EMI filter to the input of the power supply. An EMI filter generally utilizes at least one inductor, capacitor and resistor in combination. However, the greater EMI produced by the power supply the larger the

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components that are utilized as part of the EMI filter. The cost of the EMI filter is in large part determined by the size of the inductor and capacitor utilized. The longer the components, the higher the cost of the power supply. Further, simply utilizing an EMI filter does not address the radiated EMI.

Another problem associated with pulse width modulated switches results from operation of the power supply at start up. At start up, the voltage, current and power at the output of the power supply will essentially be zero. The pulse width modulated switch will then conduct for the maximum possible amount of time in each cycle of operation. The result of this is a maximum inrush current into the power supply. The maximum inrush current is greater than the current that is utilized during normal operation of the power supply. The maximum inrush current stresses the components of power supply and switch. Stress is specifically a problem for the switch, or transistor, the transformer of the power supply, and the secondary side components of the power supply. The stress caused by the maximum inrush current decreases the overall life of the power supply and increases the cost of the power supply because the maximum rating of the components used in the power supply to not destruct from the inrush currents will be greater than the maximum rating required for normal operation.

Further, when the pulse width modulated switch conducts for the maximum possible amount of time in each cycle of operation the voltage, current and power at the output of the power supply rise rapidly. Since the feedback circuit of the power supply often does not respond as fast as the operating frequency of the switch, the rapid rise of the voltage, current and power will often result in an overshoot of the maximum voltage in the regulation range which will cause damage to the device being supplied power by the power supply.

Referring to FIG. 1 a known power supply that attempts to minimize EMI and reduce startup stress is depicted. A rectifier 10 rectifies the filtered AC mains voltage 5, from EMI filter 120, input by the AC mains to generate a rectified voltage 15. Power supply capacitor 20 then generates a substantially DC voltage with a ripple component. The rectified voltage 15 with ripple component is provided to the primary winding 35 of transformer 40 that is used to provide power to secondary winding 45. The output of secondary winding 45 is provided to secondary rectifier 50 and secondary capacitor 55 that provide a secondary DC voltage 60 at the power supply output 65 to the device that is coupled to the power supply.

In order to maintain the secondary DC voltage within a regulate range a feedback loop including an optocoupler 70, zener diode 75 and a feedback resistor 80 provides a signal indicative of the voltage at the power supply output 65 to feedback pin 85 of pulse width modulated switch 90. The voltage magnitude at the feedback terminal is utilized to vary the duty cycle of a switch coupled between the drain terminal 95 and common terminal 100 of the pulse width modulated switch 90. By varying the duty cycle of the switch the average current flowing through the primary winding and therefore the energy stored by the transformer 40 which in turn controls the power supplied to the power supply output 65 is kept within the regulated range. A compensation circuit 105 is coupled to the feedback pin 85 in order to lower the bandwidth of the frequency of operation of the pulse width modulator.

Inrush currents are minimized at start up by use of soft start capacitor 110. Soft start functionality is termed to be a functionality that reduces the inrush currents at start up. At

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this instant a current begins to flow through feedback resistor 80 and thereby into soft start capacitor 110. As the voltage of soft start capacitor 110 increases slowly, current will flow through light emitting diode 115 of optocoupler 70 thereby controlling the duty cycle of the switch. Once the voltage of the soft start capacitor 110 reaches the reverse breakdown voltage of zener diode 75 current will flow through zener diode 75. The approach described above will reduce the inrush currents into the power supply, however, it will be several cycles before the light emitting diode 115 will begin conducting. During the several cycles the maximum inrush current will still flow through the primary winding and other secondary side components. During these cycles the transformer may saturate, and therefore the transformer may have to be designed utilizing a higher core size than would be required for normal operation even with the use of soft start capacitor as in FIG. 1.

To reduce the EMI output by the power supply an EMI filter 120 is utilized. Additionally, pulse width modulated switch 90 is equipped with frequency oscillation terminals 125 and 130. Frequency oscillation terminal 125 and 130 receive a jitter current 135 that varies according to the ripple component of substantially DC voltage 25. The jitter current 135 is used to vary the frequency of the saw-toothed waveform generated by the oscillator contained in the pulse width modulated switch 90. The saw toothed waveform generated by the oscillator is compared to the feedback provided at the feedback pin 85. As the frequency of the saw toothed waveform varies, so will the switching frequency of the switch coupled between the drain and common terminal. This allows the switching frequency of the switch to be spread over a larger bandwidth, which minimizes the peak value of the EMI generated by the power supply at each frequency. By reducing the EMI the ability to comply with government standards is increased, because the government standards specify quasi-peak and average values at given frequency levels. Varying the frequency of operation of the pulse width modulated switch by varying the oscillation frequency of the oscillator is referred to as frequency jitter.

A problem associated with the EMI reduction scheme described with respect to FIG. 1 is that the ripple component will have variances due to variations in the line voltage and output load. Additionally, since the ripple may vary, design and the component value of EMI resistor 140 is difficult to determine and correspondingly design of the power supply becomes problematic.

SUMMARY OF THE INVENTION

In one embodiment the present invention comprises a pulse width modulated switch comprising a switch that allows a signal to be transmitted between a first terminal and a second terminal according to a drive signal. The pulse width modulated switch also comprises a frequency variation circuit that provides a frequency variation signal and an oscillator that provides an oscillation signal having a frequency that varies within a frequency range according to the frequency variation signal. The oscillator further provides a maximum duty cycle signal comprising a first state and a second state. The pulse width modulated circuit further comprises a drive circuit that provides the drive signal when the maximum duty cycle signal is in the first state and a magnitude of the oscillation signal is below a variable threshold level.

Another embodiment of the present invention comprises a pulse width modulated switch comprising a switch comprising a control input, the switch allowing a signal to be

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transmitted between a first terminal and a second terminal according to a drive signal. The pulse width modulated switch also comprises an oscillator that provides a maximum duty cycle signal comprising an on-state and an off-state, a drive circuit that provides the drive signal, and a soft start circuit that provides a signal instructing said drive circuit to disable the drive signal during at least a portion of said on-state of the maximum duty cycle.

In an alternate embodiment the present invention comprises a regulation circuit comprising a switch that allows a signal to be transmitted between a first terminal and a second terminal according to a drive signal, a drive circuit that provides the drive signal and a soft start circuit that provides a signal instructing the drive circuit to disable the drive signal.

In yet another embodiment the present invention comprises a regulation circuit comprising a switch that allows a signal to be transmitted between a first terminal and a second terminal according to a drive signal, a frequency variation circuit that provides a frequency variation signal, and a drive circuit that provides a drive signal for a maximum time period of a time duration cycle. The time duration of the cycle varies according to the frequency variation signal.

In the above referenced embodiments the pulse width modulated switch or regulation circuit may comprise a monolithic device.

An object of an aspect of the present invention is directed to a pulse width modulated switch that has integrated soft start capabilities.

Another object of an aspect of the present invention is directed toward a pulse width modulated switch that has integrated frequency variation capabilities.

Yet another object of an aspect of the present invention is directed toward a pulse width modulated switch that has integrated frequency variation capabilities and integrated soft start capabilities.

A further object of an aspect of the present invention is directed toward a low cost regulated power supply that has both soft start and frequency variation capabilities.

This and other objects and aspects of the present inventions are taught, depicted and described in the drawings and the description of the invention contained herein.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a known power supply utilizing a pulse width modulated switch, and external soft start, and frequency jitter functionality.

FIG. 2 is a presently preferred power supply utilizing an pulse width modulated switch according to the present invention.

FIG. 3 is a presently preferred pulse width modulated switch according to the present invention.

FIG. 4 is a timing diagram of the soft start operation of the presently preferred pulse width modulated switch according to the present invention.

FIG. 5 is a timing diagram of the frequency jitter operation of the presently preferred pulse width modulated switch according to the present invention.

FIG. 6 is an alternate presently preferred pulse width modulated switch according to the present invention.

FIG. 7 is a timing diagram of the operation of the alternate presently preferred pulse width modulated switch of FIG. 6 according to the present invention.

FIG. 8 is a presently preferred power supply utilizing a regulation circuit according to the present invention.

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FIG. 9 is a presently preferred regulation circuit according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 2, EMI filter 200 is coupled to an AC mains voltage 205. The AC mains voltage 205 is rectified by rectifier 210. The rectified voltage 215 is provided to power supply capacitor 220 which provides a substantially DC voltage 225. The substantially DC voltage 225 is provided to the primary winding 230 of transformer 235 which stores the energy provided to the primary winding 230. When the primary winding 230 is no longer receiving energy, energy is delivered by the transformer 235 to the secondary winding 240. The voltage induced across the secondary winding 240 is rectified by rectifier 245 and then transformed into secondary substantially DC voltage 265 by secondary capacitor 260 and provided to the power supply output 267.

Energy is no longer provided to the primary winding 230 when the pulse width modulated switch 262, which is coupled to the primary winding 230, ceases conduction. Pulse width modulated switch 262 is a switch that is controlled by a pulse width modulated signal. Pulse width modulated switch 262 conducts and ceases conduction according to a duty cycle, that is in part determined by feedback from the power supply output 267. Pulse width modulated switch 262 is a switch that operates according to pulse width modulated control. Feedback to the pulse width modulated switch 262 is accomplished by utilization of feedback circuit 270, which is presently preferred to comprise a zener diode 275 in series with a resistor 280 and optocoupler 285. Optocoupler 285 provides a feedback current 290 to feedback terminal 295 of pulse width modulated switch 262. The feedback current is utilized to vary the duty cycle of a switch coupled between the first terminal 300 and second terminal 305 and thus regulate the output voltage, current or power of the power supply.

Although, it is presently preferred that the output voltage is utilized for feedback, the present invention is also capable of utilizing either the current or power at the power supply output 267 without departing from the spirit and scope of the present invention.

A portion of the current supplied at the feedback terminal 295 is utilized to supply bias power for operation of the pulse width modulated switch 262. The remainder of the current input at the feedback terminal 295 is utilized to control the duty cycle of the pulse width modulated switch 262, with the duty cycle being inversely proportional to the feedback current.

A bias winding 310 is utilized to bias optocoupler 285 so that a feedback current can flow when light emitting diode 315 of optocoupler 285 conducts. The power supplied by the bias winding 310 is also used to charge pulse width modulation capacitor 330, the energy from which is utilized to power the pulse width modulated switch 262.

Overvoltage protection circuit 335 is utilized to prevent overvoltages from propagating through to the transformer 235.

Pulse width modulated switch 262 is supplied power during start up of the power supply by current flowing into the first terminal 300. An embodiment of one type of apparatus and method for designing a configuration for providing power to pulse width modulated switch through first terminal 300 is disclosed in commonly owned U.S. Pat. No. 5,014,178 which is incorporated herein by reference in its entirety.

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The drain terminal 300, source terminal 305 and feedback terminal 295 are the electrical input and/or output points of the pulse width modulated switch 262. They need not be part of a monolithic device or integrated circuit, unless the pulse width modulated switch 262 is implemented utilizing a monolithic device or integrated circuit.

Pulse width modulated switch 262 also may have soft start capabilities. When the device to which the power supply is coupled is switched on, a power up signal is generated within the internal circuitry of pulse width modulated switch 262. The power up signal is used to trigger soft start circuitry that reduces the duty cycle of the switch that operates within the pulse width modulated switch 262 for a predetermined period of time, which is presently preferred to be ten (10) milliseconds. Once soft start operation is completed, pulse width modulated switch 262 operates according to its regular duty cycle.

Alternatively, or in addition to soft start functionality, pulse width modulated switch 262 may also have frequency jitter functionality. That is, the switching frequency of the pulse width modulated switch 262 varies according to an internal frequency variation signal. This has an advantage over the frequency jitter operation of FIG. 1 in that the frequency range of the presently preferred pulse width modulated switch 262 is known and fixed, and is not subject to the line voltage or load magnitude variations. At low powers, those less than approximately ten (10) watts, the common mode choke which is often utilized as part of the EMI filter 120 can be replaced with inductors or resistors.

As can be seen when comparing the power supply of FIG. 1 to that of FIG. 2 the number of components utilized is reduced. This reduces the overall cost of the power supply as well as reducing its size.

Referring to FIG. 3, frequency variation signal 400 is utilized by the pulse width modulated switch 262 to vary its switching frequency within a frequency range. The frequency variation signal 400 is provided by frequency variation circuit 405, which preferably comprises an oscillator that operates at a lower frequency than main oscillator 465. The frequency variation signal 400, is presently preferred to be a triangular waveform that preferably oscillates between four point five (4.5) volts and one point five (1.5) volts. Although the presently preferred frequency variation signal 400 is a triangular waveform, alternate frequency variation signals such as ramp signals, counter output signals or other signals that vary in magnitude during a fixed period of time may be utilized as the frequency variation signal.

The frequency variation signal 400 is provided to soft start circuit 410. During operation soft start circuit 410 is also provided with pulse width modulation frequency signal 415 and power up signal 420. Soft start enable signal 421 goes high at power up and remains high until oscillator signal 400 reaches its peak value for the first time. Soft start circuit 410 will provide a signal to or-gate 425 to reset latch 430 thereby deactivating conduction by the switch 435, which is presently preferred to be a MOSFET. Soft start circuit 410 will instruct switch 435 to cease conduction when the soft start enable signal 421 is provided and the magnitude of the frequency variation signal 400 is less than the magnitude of pulse width modulation signal 415. In other words, start up circuit 410 will allow the switch 435 to conduct as long as soft start enable signal is high and the magnitude of the pulse width modulation signal 415 is below the magnitude of frequency variation signal 400 as depicted in FIG. 4. In this way, the inrush current at startup will be limited for all cycles of operation, including the first

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cycle. By limiting the inrush current during all cycles of startup operation, the maximum current through each of the components of the power supply is reduced and the maximum current rating of each component can be decreased. The reduction in the ratings of the components reduces the cost of the power supply. Soft start signal 440 will no longer be provided by the frequency variation circuit 485 when the frequency variation signal 400 reaches its peak magnitude.

Operation of soft start circuit 410 will now be explained. Soft start circuit 410 comprises a soft start latch 450 that at its set input receives the power up signal 420 and its reset input receives the soft start signal 440. Soft start enable signal 421 is provided to one input of soft start and-gate 455 while the other input of soft start and-gate 455 is provided with an output from soft start comparator 460. The output of soft start comparator 460 will be high when the magnitude of frequency variation signal 400 is less than the magnitude of pulse width modulation oscillation signal 415.

The pulse width modulated switch 262 depicted in FIG. 3 also has frequency jitter functionality to help reduce the EMI generated by the power supply and pulse width modulated switch 262. Operation of the frequency jitter functionality will now be explained. Main oscillator 465 has a current source 470 that is mirrored by mirror current source 475. Main oscillator drive current 615 is provided to the current source input 485 of PWM oscillator 480. The magnitude of the current input into current source input 485 of PWM oscillator 480 determines the frequency of the pulse width modulation oscillation signal 415 which is provided by PWM oscillator 480. In order to vary the frequency of pulse width modulation oscillation signal 415, an additional current source 495 is provided within main oscillator 465. The additional current source 495 is mirrored by additional current source mirror 500. The current provided by additional current source 495 is varied as follows. Frequency variation signal 400 is provided to the gate of main oscillator transistor 505. As the magnitude of frequency variation signal 400 increases so does the voltage at the source of main oscillator transistor 505, due to the increasing voltage at the gate of main oscillator transistor and the relatively constant voltage drop between the gate and source of the main oscillator transistor 505. As the voltage at the source of main oscillator transistor 505 increases so does the current flowing through the main oscillation resistor 510. The current flowing through main oscillation resistor 510 is the same as the current flowing through additional current source 495 which is mirrored by additional current source mirror 500. Since, the presently preferred frequency variation signal 400 is a triangular waveform having a fixed period, the magnitude of the current input by additional current source mirror 500 will vary linearly with the magnitude of the rising and falling edges of the frequency variation signal 400. If the frequency variation signal 400 is a ramp signal, the frequency would linearly rise to a peak and then immediately fall to its lowest value. In this way, the current provided to current source input 485 of PWM oscillator 480 is varied in a known fixed range that allows for easy and accurate frequency spread of the high frequency current generated by the pulse width modulated switch. Further, the variance of the frequency is determined by the magnitude of the current provided by additional current source mirror 500, which is in turn a function of the resistance of main oscillation resistor 510.

Frequency variation circuit 485 includes a current source 525 that produces a fixed magnitude current 530 that determines the magnitude of the frequency of the frequency variation signal 400. Although, the presently preferred cur-

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rent 530 has a fixed magnitude, the frequency variation signal can be generated utilizing a variable magnitude current, if a variable current is generated the frequency spread would not be fixed in time but would vary with the magnitude of current 530. The fixed magnitude current 530 is fed into first transistor 535, mirrored by second transistor 540 and fed into third transistor 545. The frequency variation signal 400 is generated by the charging and discharging of frequency variation circuit capacitor 550. Frequency variation circuit capacitor 550 is presently preferred to have a relatively low capacitance, which allows for integration into a monolithic chip in one embodiment of the pulse width modulated switch 262. The frequency variation signal 400 is provided to upper limit comparator 555 and lower limit comparator 560. The output of upper limit comparator 555 will be high when the magnitude of the frequency variation signal 400 exceeds the upper threshold voltage 552 which is presently preferred to be four point five (4.5) volts. The output of lower limit comparator 560 will be high when the magnitude of frequency variation signal 400 exceeds lower threshold voltage 557 which is presently preferred to be one point five volts (1.5) volts. The output of upper limit comparator 555 is provided to the frequency variation circuit inverter 565 the output of which is provided to the reset input of frequency variation circuit latch 570. The set input of frequency variation circuit latch 570 receives the output of lower limit comparator 560. In operation, the output of lower limit comparator 560 will be maintained high for the majority of each cycle of frequency variation signal 400 because the magnitude of frequency variation signal will be maintained between upper threshold 552, 4.5 volts, and the lower threshold 557, 1.5 volts. The output of upper limit comparator 555 will be low until the magnitude of frequency variation signal 400 exceeds upper level threshold 552. This means that the reset input will receive a high signal until the magnitude of the frequency variation signal 400 rises above the upper threshold signal 552.

The charge signal 575 output by frequency variation circuit latch 570 will be high until the frequency variation signal 400 exceeds the upper threshold limit signal 552. When the charge signal 575 is high, transistors 585 and 595 are turned off. By turning off transistors 585 and 595 current can flow into frequency variation circuit capacitor 550, which steadily charges frequency variation circuit capacitor 550 and increases the magnitude of frequency variation signal 400. The current that flows into frequency variation circuit capacitor 550 is derived from current source 525 because the current through transistor 590 is mirrored from transistor 580, which is mirrored from transistor 535.

During power up, when power-up signal 420 is low, the output of inverter 605 is high which turns on transistor 600 causing frequency variation signal 400 to go low. The frequency variation signal 400 is presently preferred to start from its lowest level to perform the soft start function during its first cycle of operation.

Steady-state operation of the pulse width modulated switch 262, i.e. non start up operation, will now be described. PWM oscillator 480 provides pulse width modulation oscillation signal 415 to pulse width modulation comparator 609, the output of which will be high when the magnitude of pulse width modulation signal 415 is greater than the magnitude of a feedback signal 296 which is a function of the input provided at feedback terminal 295. When the output of pulse width modulation comparator 609 is high or-gate 425 is triggered to go high, which in turn resets pulse width modulation latch 430, removing the on signal from the control input switch 435, thereby turning off

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switch 435. Pulse width modulation latch 430 is set by clock signal 603, which is provided at the beginning of each cycle of pulse width modulation oscillator 400. Drive circuit 615, which is presently preferred to be an and-gate, receives the output of pulse width modulation latch 430, power up signal 420, and maximum duty cycle signal 607. As long as each one of the signals is high, drive signal 610 is provided to the gate of MOSFET 435, which is coupled between first terminal 300 and second terminal 305 of the pulse width modulated switch 262. When any of the output of pulse width modulation latch 430, power up signal 420, or maximum duty cycle signal 607 goes low drive signal 610 is no longer provided and switch 435 ceases conduction.

Referring to FIG. 4, frequency variation signal 400 preferably has a period, which is greater than that of pulse width modulated oscillation signal 415. The presently preferred period for frequency variation signal 400 is twenty (20) milliseconds, in order to allow for a smooth start up period which is sufficiently longer than the period of pulse width modulated signal 415 which is presently preferred to be ten (10) microseconds. Drive signal 610 will be provided only when the magnitude of pulse width modulated signal 415 is less than the magnitude of frequency variation signal 400. Further, frequency variation signal 400 will be preferably initiated starting from low voltage when power up signal 420 is provided.

Referring to FIG. 5, frequency variation signal 400 which is presently preferred to have a constant period is provided to the main oscillator 445. The magnitude of the pulse width modulator current 615 will approximately be the magnitude of frequency variation signal 400 divided by the resistance of resistor 510 plus the magnitude of the current produced by current source 470. In this way the pulse width modulator current 615 will vary with the magnitude of the frequency variation signal 400. The result is that the frequency of pulse width modulation signal is varied according to the magnitude of this current. It is presently preferred that the pulse width modulator current source produces a constant current having a magnitude of twelve point one (12.1) microamperes, and that frequency variation signal induced current 627 varies between zero (0) and eight hundred (800) nanoamperes. Thereby spreading the frequency of operation of the pulse width modulation oscillator 400 and reducing the average magnitude and the quasi-peak magnitude at all frequency levels of the EMI generated by the power supply.

Referring to FIG. 6, an alternate presently preferred pulse width modulated switch 262 includes all of the same components as described with respect to FIG. 3. In addition to these components, a second frequency variation circuit current source 660 and transistor 655 are added to the frequency variation circuit 405. Transistor 655 is activated only when the output of soft start latch 450 goes low. When transistor 655 is activated the current provided to the frequency variation circuit 405 increases as does the frequency of frequency variation signal 400. However, transistor 655 will only be turned on when the output of soft start latch 450 goes low, i.e. when the magnitude of frequency variation signal 400 first reaches the upper threshold after power up. The period of frequency variation signal 400 will then increase after its first half cycle. This will decrease the period of the cycle during which the frequency is spread, without decreasing the frequency range. The benefit of the decreased cycle period will further decrease the quasi-peak levels of the EMI due to spending less time at each frequency level.

Referring to FIG. 7, operation of the frequency variation circuit 405 of FIG. 6 is depicted. Frequency variation signal

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405 will preferably have a period of ten (10) milliseconds for its first half cycle. After that, when the transistor 655 is turned on the period is preferably decreased to five (5) milliseconds. Pulse width modulated switch 262 is presently preferred to be a monolithic device.

Referring to FIG. 8, a power supply comprises a bridge rectifier 710 that rectifies an input AC mains voltage. Power supply capacitors 720 charge with the rectified AC mains voltage to maintain an input DC voltage 725. A presently preferred range for input DC voltage 725 is approximately one hundred (100) to four hundred (400) volts to allow for operation based upon worldwide AC mains voltages which range between eighty five (85) and two hundred sixty five (265) volts. The presently preferred power supply also includes harmonic filter components 910 which in combination with capacitors 720 reduce the harmonic current injected back into the power grid. Transformer 730 includes a primary winding 740 magnetically coupled to secondary winding 750. The secondary winding 750 is coupled to a diode 760 that is designed to prevent current flow in the secondary winding 750 when the regulation circuit 850 is conducting (on-state). A capacitor 770 is coupled to the diode 760 in order to maintain a continuous voltage on a load 780 which has a feedback circuit coupled to it. A presently preferred feedback circuit comprises an optocoupler 800 and zener diode 820. The output of optocoupler 800 is coupled to the feedback terminal 825 of regulation circuit 850. The presently preferred regulation circuit 850 switches on and off at a duty cycle that is constant at a given input DC voltage 740. A regulation circuit power supply bypass capacitor 860 is coupled to and supplies power to regulation circuit 850 when the regulation circuit 850 is in the on-state.

Operation of the power supply will now be described. An AC mains voltage is input through EMI filter 700 into bridge rectifier 710 which provides a rectified signal to power supply capacitors 720 that provide input DC voltage 725 to primary winding 740. Regulation circuit 850, which preferably operates at a constant frequency and about constant duty cycle at a given input DC voltage 725, allows current to flow through primary winding 740 during its on state of each switching cycle and acts as open circuit in its off state. When current flows through primary winding 740 transformer 730 is storing energy, when no current is flowing through primary winding 740 any energy stored in transformer 730 is delivered to secondary winding 750. Secondary winding 750 then provides the energy to capacitor 770. Capacitor 770 delivers power to the load 780. The voltage across the load 780 will vary depending on the amount of energy stored in the transformer 730 in each switching cycle which is in turn dependent on the length of time current is flowing through primary winding 740 in each switching cycle which is presently preferred to be constant at a given input DC voltage 725. The presently preferred regulation circuit 850 allows the voltage delivered to the load to be maintained at a constant level.

It is presently preferred that the sum of the voltage drop across optocoupler 800 and the reverse break down voltage of zener diode 820 is approximately equal to the desired threshold level. When the voltage across the load 780 reaches the threshold level, current begins to flow through the optocoupler 800 and zener diode 820 that in turn is used to disable the regulation circuit 850. Whenever regulation circuit 850 is in the off-state the regulation circuit power supply bypass capacitor 860 is charged to the operating supply voltage, which is presently preferred to be five point seven (5.7) volts by allowing a small current to flow from bypass terminal 865 to the regulation circuit power supply

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bypass capacitor 860. Regulation circuit power supply bypass capacitor 860 is used to supply power to operate regulation circuit 850 when it is in the on-state.

When the regulation circuit 850 is disabled, an open circuit condition is created in primary winding 740 and transformer 730 does not store energy. The energy stored in the transformer 730 from the last cycle of regulation circuit 850 is then delivered to secondary winding 750 which in turn supplies power to the load 780. Once the remaining energy in transformer 750 is delivered to the load 780 the voltage of the load 780 will decrease. When the voltage at the load 780 decreases below the threshold level, current ceases to flow through optocoupler 800 and regulation circuit 850 resumes operation either instantaneously or nearly instantaneously.

The presently preferred regulation circuit 850 has a current limit feature. The current limit turns off the regulation circuit 850, when the current flowing through the regulation circuit 850 rises above a current threshold level. In this way regulation circuit 850 can react quickly to changes such as AC ripple that occur in the rectified AC mains voltage, and prevents the propagation of the voltage changes to the load. The current limit increases the responsiveness of the regulation circuit to input voltage changes and delivers constant power output independent for the AC mains input voltage.

Although the presently preferred power supply of FIG. 8 utilizes current mode regulation and a feedback circuit that includes an optocoupler and zener diode, the present invention is not to be construed as to be limited to such a feedback method or circuit. Either current or voltage mode regulation may be utilized by the present invention without departing from the spirit and scope of the present invention so long as a signal indicative of the power supplied to the load is supplied to the feedback terminal 825 of the regulation circuit 850. Additionally, although the presently preferred power supplies both utilize an optocoupler and zener diode as part of feedback circuits other feedback circuits may be utilized by the present invention without departing from the spirit and scope of the present invention.

Regulation circuit 850 also may have integrated soft start capabilities. When the device to which the power supply is coupled is switched on, a power up signal is generated within the internal circuitry of regulation circuit 850. A power up signal is used to trigger soft start circuitry that reduces the duty cycle of the switch that operates within the pulse width modulated switch 262 for a predetermined period of time, which is presently preferred to be ten (10) milliseconds. Once soft start operation is completed, regulation circuit 850 operates according to its regular duty cycle.

Alternatively, or in addition to soft start functionality, regulation circuit 850 may also have frequency jitter functionality. That is, the switching frequency of the regulation circuit 850 varies according to an internal frequency variation signal. This has an advantage over the frequency jitter operation of FIG. 1 in that the frequency range of the presently regulation circuit 850 is known and fixed, and is not subject to the line voltage or load magnitude variations.

Referring to FIG. 9, frequency variation circuit 405 and main oscillator 445 function as described with respect to FIG. 3. In operation it is the variance of the high and low states of maximum duty cycle signal 607 that generates the frequency jitter functionality of the regulation circuit 850. A presently preferred regulation circuit 850 and its steady-state operation is depicted and described in copending patent application Ser. No. 09/032,520 which is hereby incorporated by reference in its entirety.

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The regulation circuit of FIG. 9 can be modified to include a second current source to further increase the period of main oscillation signal 415 which achieves the same result and function as described with respect of FIGS. 6 and 7.

The soft start functionality of the presently preferred regulation circuit 850 of FIG. 9, will shorten the on-time of switch 435 to less than the time of the maximum duty cycle signal 607 as long as the soft start enable signal 421 is provided and the magnitude of frequency variation signal 400 is less than the magnitude of main oscillation signal 415.

The presently preferred regulation circuit 850 preferably comprises a monolithic device.

While the embodiments, applications and advantages of the present invention have been depicted and described, there are many more embodiments, applications and advantages possible without deviating from the spirit of the inventive concepts described herein. Thus, the inventions are not to be restricted to the preferred embodiments, specification or drawings. The protection to be afforded this patent should therefore only be restricted in accordance with the spirit and intended scope of the following claims.

What is claimed is:

1. A pulse width modulated switch comprising
 - a first terminal;
 - a second terminal;
 - a switch comprising a control input, the switch allowing a signal to be transmitted between said first terminal and said second terminal according to a drive signal provided at said control input;
 - an oscillator that provides a maximum duty cycle signal comprising an on-state and an off-state;
 - a drive circuit that provides said drive signal according to said maximum duty cycle signal; and
 - a soft start circuit that provides a signal instructing said drive circuit to disable said drive signal during at least a portion of said on-state of said maximum duty cycle.
2. The pulse width modulated switch of claim 1 wherein said a first terminal, said second terminal, said switch, said oscillator, said drive circuit and said soft start circuit comprise a monolithic device.
3. The pulse width modulated switch of claim 1 further comprising an additional oscillator that provides a soft start signal to said soft start circuit, and wherein when said soft start signal is removed said soft start circuit ceasing operation.
4. The pulse width modulated circuit of claim 3 wherein said additional oscillator further comprises
 - a comparator that provides a comparator signal when a magnitude of a reference signal is greater than or equal to a magnitude of said frequency variation oscillation signal, and
 - an inverter that receives said comparator signal and provides said soft start signal.
5. The pulse width modulated switch of claim 1 further comprising a frequency variation circuit that provides a frequency variation signal, wherein said oscillator provides an oscillation signal and wherein said soft start circuit provides said signal instructing said drive circuit to disable said drive signal when a magnitude of said oscillation signal is greater than a magnitude of said frequency variation signal.
6. The pulse width modulated switch of claim 5 wherein said oscillator comprises an input that receives said frequency signal and said oscillation signal comprises a frequency range, and wherein said frequency of said oscillation

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signal varies within said frequency range according to a magnitude of said frequency variation signal.

7. The pulse width modulated switch of claim 6 wherein said oscillator further comprises a current source, wherein said frequency of said oscillation signal is a function of a sum of a magnitude of a current provided by said current source and said magnitude of said frequency variation signal.

8. The pulse width modulated switch of claim 1 further comprising

- a rectifier comprising a rectifier input and a rectifier output, said rectifier input receiving an AC mains signal and said rectifier output providing a rectifier signal;
- a power supply capacitor that receives said rectified signal;
- a first winding comprising a first terminal and a second terminal, said first winding receiving a substantially DC signal from said power supply capacitor, said second terminal of said first winding coupled to said first terminal of said pulse width modulated switch; and
- a second winding magnetically coupled to said first winding, said first winding capable of being coupled to a load.

9. A regulation circuit comprising

- a first terminal;
- a second terminal;
- a switch comprising a control input, said switch allowing a signal to be transmitted between said first terminal and said second terminal according to a drive signal provided at said control input;
- a drive circuit that provides said drive signal for a maximum time period of a cycle; and
- a soft start circuit that provides a signal instructing said drive circuit to disable said drive signal during at least a portion of said maximum time period.

10. The regulation circuit of claim 9 further comprising an oscillator that provides a maximum duty cycle signal to said drive circuit, said maximum duty cycle signal comprising an on-state for said maximum time period.

11. The regulation circuit of claim 10 further comprising a frequency variation circuit that provides a frequency variation signal, wherein said oscillator provides an oscillation signal and wherein said soft start circuit provides said signal instructing said drive circuit to disable said drive

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signal when a magnitude of said oscillation signal is greater than a magnitude of said frequency variation signal.

12. The regulation circuit of claim 9 further comprising an additional oscillator that provides a soft start signal to said soft start circuit, and wherein when said soft start signal is removed said soft start circuit ceasing operation.

13. The regulation circuit of claim 12 wherein said additional oscillator further comprises

- a comparator that provides a comparator signal when a magnitude of a reference signal is greater than or equal to a magnitude of said additional oscillation signal, and
- an inverter that receives said comparator signal and provides said soft start signal.

14. The regulation circuit of claim 9 further comprising a frequency variation circuit that provides a frequency variation signal and wherein said maximum time period varies according to a magnitude of said frequency variation signal.

15. The regulation circuit of claim 9 further comprising a feedback terminal and wherein when a signal is received at said feedback terminal said drive signal is discontinued for at least one cycle.

16. The regulation circuit of claim 9 wherein said first terminal, said second terminal, said oscillator and said soft start circuit comprise a monolithic device.

17. The regulation circuit of claim 16 further comprising a current limit circuit that provides a signal instructing said drive circuit to discontinue said drive signal when a current received at said first terminal of said regulation circuit is above a threshold level.

18. The regulation circuit of claim 9 further comprising a rectifier comprising a rectifier input and a rectifier output, said rectifier input receiving an AC mains signal and said rectifier output providing a rectifier signal;

- a power supply capacitor that receives said rectified signal;
- a first winding comprising a first terminal and a second terminal, said first winding receiving a substantially DC signal from said power supply capacitor, said second terminal of said first winding coupled to said first terminal of said regulation circuit; and
- a second winding magnetically coupled to said first winding, said first winding capable of being coupled to a load.

* * * * *

FCS0000224

EXHIBIT E

From: Michael Headley [mailto:Headley@fr.com]
Sent: Thursday, May 24, 2007 12:22 PM
To: Ramsey, Gabriel; VanderZanden, Brian
Cc: Howard Pollack; William Marsden; de Blank, Bas
Subject: Re: PI-Fairchild: PI's motion in limine re: Intersil documents

Gabe & Brian,

I understand Gabe spoke with Howard about the issue raised in Brian's e-mail (below), but I wanted to write anyway to confirm you're both in the loop on our response.

Per Howard's discussion with Gabe, now that Fairchild has offered to make Mr. Beasom available for deposition, we expect his testimony will moot the issue in our motion *in limine*, but until we resolve the issue and have his testimony we cannot waive our evidentiary objections to the documents. Please feel free to note as much in the opposition brief you file addressing all of the motions *in limine* tomorrow, and let us know if you have any further questions.

Regards,
Michael

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(650) 839-5071 (fax)

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From: VanderZanden, Brian [mailto:bvanderzanden@orrick.com]
Sent: Wednesday, May 23, 2007 1:54 PM
To: Michael Headley
Cc: Howard Pollack; William Marsden; de Blank, Bas; Ramsey, Gabriel
Subject: PI-Fairchild: PI's motion in limine re: Intersil documents

5/24/2007

Michael,

Your May 18, 2007 letter states that Power Integrations would be willing to withdraw its motion in limine to preclude reliance upon the Intersil exhibits if Fairchild could make Mr. Beasom available for deposition prior to trial. Now that the parties are working to schedule the depositions of both Messrs. Beasom and Eklund, please confirm that Power Integrations will withdraw its motion in limine.

Regards,

BRIAN VANDERZANDEN

Associate

ORRICK, HERRINGTON & SUTCLIFFE LLP

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5/24/2007

EXHIBIT F

REDACTED

EXHIBIT G

REDACTED

EXHIBIT H

REDACTED